SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1905.

GENERAL PHYSICS.

1536. *Sarrut's Parallel Motion.* **G. T. Bennett.** (Phil. Mag. 9. pp. 803–810, June, 1905.)—The Peaucellier cell and other such linkages give rectilinear motion only to a single point. Sarrut's mechanism gives rectilinear translational motion to a whole piece. A board A is to have rectilinear motion, say vertically up and down, relative to a base B. Four connecting pieces RSTU are used. The pieces ARSB are connected by three parallel horizontal hinges, and the pieces ATUB by three more, the directions being different, *e.g.*, parallel to two adjacent sides of A. The board A then has a movement which is rectilinear and vertical. By making one or both of the sets of hinges ARSB, ATUB concurrent in a finite point, the motion of A relative to B is one of pure rotation about a virtual hinge line. The mechanism requires fewer connecting pieces and hinges than any other method of obtaining rectilinear motion of a piece. A. W.

1537. *The Capillary Motor.* **A. Gradenwitz.** (Scientific American, 92. p. 486, June 17, 1905.)—A brief illustrated description is given of the motor devised by G. Leboyer. This consists of an inverted U-shaped upright frame of domite, a mineral found to possess special capillary properties, a small water-wheel, and strips of some spongy material such as amadou, which conduct the water raised to the top of the framework by capillary attraction, to the paddles of the water-wheel. The paddles are themselves made of domite or other absorbent substance, and, becoming heavier from the water led to them by the amadou strips, a partial rotation of the wheel takes place. The water on the paddles evaporates as the rotation of the wheel removes the paddles from contact with the strips, and so an intermittent rotary motion is produced which may be used for driving purposes; but the power is, of course, small. L. H. W.

1538. *Application of the Baroscope to the Determination of Densities of Gases and Vapours.* **A. W. Gray.** (Konink. Akad. Wetensch. Amsterdam, Versl. 13. pp. 822–824, May 11, 1905. Proc. 7. pp. 770–772, May 25, 1905. Communication No. 94A, from the Phys. Lab. at Leyden.)—The author describes a new form of baroscope, consisting of a capillary glass tube which carries at one end a closed bulb and at the other a hemispherical shell of the same diameter, weight, and kind of glass, and is fastened to a horizontal quartz fibre stretched on a glass frame. The glass tube has also a small mirror at its middle, so that rotations about the quartz fibre as axis can be measured by means of a telescope and scale. The whole is placed within a glass tube containing a sensitive thermometer and communicating with a manometer. With the author's instrument, in which the quartz fibre has a length of 1·4 cm. and a diam. of about 0·005 cm., and the distance between the mirror and scale is 255 cm., a change of 0·1 mm. in the scale reading indicates a change of about 1 part in 6,000 in the density of air under ordinary circumstances.

T. H. P.

1539. *Compressibility of Various Gases at less than Atmospheric Pressure, and Determination of their Molecular Weights.* **A. Jaquerod** and **O. Scheuer.** (Comptes Rendus, 140. pp. 1384–1386, May 22, 1905.)—The results of the authors' measurements of the compressibility of various gases at pressures less than that of the atmosphere are given in the following table, where A is the deviation per cent. from Boyle's law and a is defined by the equation, $1 - p_1v_1/p_0v_0 = a(p_1 - p_0)$, while L represents the weight per litre of the gas and M the found molecular weight—

	Pressure.	A.	a.	L.	M.
H_2	400–800 mm.	0·0000068	− 0·00052	0·089873	2·0156
O_2	,,	0·0000127	+ 0·00097	1·42900	32·00 (base)
NO	,,	0·0000154	+ 0·00117	1·3402	30·005
NH_3	,,	0·0002008	+ 0·01527	0·7708	17·014
NH_3	200–400 mm.	0·0001997	,,	,,	,,
SO_2	400–800 mm.	0·0003141	+ 0·02386	2·92664	64·036
SO_2	200–400 mm.	0·0003106	,,	,,	,,

The calculated molecular weights practically coincide with the results given by the best analytical methods for gases remote from their boiling-points. For gases which are readily liquefiable, the molecular weights obtained are too low, probably owing to the fact that the deviation of compressibility varies appreciably with the pressure, as is clearly shown by the authors' results.

T. H. P.

1540. *Limits of Validity of Poiseuille's Law.* **E. Grüneisen.** (Phys. Tech. Reichsanstalt, Wiss. Abh. 4. pp. 153–184, 1905.)—The author has made a full study of the validity of Poiseuille's law that the velocity of flow of a liquid through a tube is proportional to the difference of pressure at the two ends of the tube. The author shows that in the case, first of all, of straight capillary tubes, the correction of Hagenbach for the kinetic energy of the issuing stream cannot in general be introduced as an exact expression for the deviations from Poiseuille's law met with. In the case of exact measurements, therefore, it is advisable to choose the dimensions such that the deviations are less than 1 per thousand. These dimensions are given by the equation $\omega = 6{\cdot}6 \times 10^{-6}\frac{\eta}{ds}\left(\frac{l}{d} - 4{\cdot}5\right)^{2\cdot08}$, where $\omega =$ the limiting velocity of flow, $s =$ the density and η the viscosity of water at 10°, $d =$ the diam. of the bore of the tube, $l =$ the length of the tube. In the case of spiral capillaries, the author shows that some care must be exercised in employing them, and in all cases the validity of Poiseuille's law for them must be tested. When this is done, however, the tubes can be safely employed, and possess certain advantages over straight tubes, especially in determining the relative viscosities of dilute solutions. A. F.

1541. *Depression due to Load at Centre of an Elastic Chain Tightly Stretched between Two Points in the Same Horizontal Plane.* **C. H. Lees.** (Phil. Mag. 9. pp. 811–816, June, 1905.)—In a previous paper [see Abstract No. 690 (1905)] a method of determining Young's modulus by the above method is described. A wire was used, and it was assumed to be straight between each point of support and the load. The author now points out that the mass and flexural rigidity of the wire should be taken into account, and proceeds to determine the effect of mass, while ignoring the flexural rigidity. For this purpose a chain is considered, and each half of it is seen to be a catenary. It is shown that provided the dip at the middle point does not exceed $\frac{1}{32}$ of the length of one-half of the chain, the tension will not exceed the elastic limit of the material, and on adding the mass of half the chain to the load at the middle, the formula obtained on the simple theory will give results correct to 1 in 800.
S. G. S.

1542. *Method of Observing Deflection with Damped Vibrations and Moving Scale-Zero.* **T. Tamaru.** (Phys. Zeitschr. 6. pp. 285–290, May 1, 1905.)—In observing the deflection of an electrometer needle produced by the change of pressure on two opposite sides of a crystal when the quadrants are connected to sheets of tinfoil fastened to these sides, it was found that a continuous change of zero takes place. This is partly due to the changing temperatures of the room, the effect being a pyroelectric one. The general problem of the motion of the needle when undergoing a damped vibration with continuously changing zero position is solved, and it is shown how the real deflection may be obtained from readings of successive turning-points of the spot of light.
S. G. S.

1543. *Dielectric Cohesion.* **E. Bouty.** (Journ. de Physique, 4. pp. 317–322, May, 1905.)—The law of the invariability of dielectric cohesion of air is valid not only up to 190° but beyond that, up to 300°. With mercury vapour (saturated) it is also valid from 44° to 254°; and the dielectric cohesion of saturated mercury vapour is 354, which corresponds, having regard to the greater density of mercury vapour, to only 0·85 times that of air; a result which (as also the brilliancy of the discharge) shows mercury vapour to resemble argon, which is similarly monatomic. Mercury vapour mixed with other gases gives dielectric cohesions below those computed from the average of the components of the mixtures; again like argon, but to a less marked degree. Mercury vapour mixed with argon has dielectric cohesion far below this average. Very small traces of mercury vapour are sufficient to make argon give out Hg spectral lines with great brilliancy. [See also Abstract No. 930 (1905).] A. D.

1544. *Work of the Reichsanstalt for the year* 1904. (Zeitschr. Instrumentenk. 25. pp. 102–116, April, and pp. 137–151, May, 1905. Abstract of Report.)—The velocity of sound and specific heat of gases have been measured by resonance methods, and such measurements are to be extended to high temperatures. Bourdon pressure gauges constructed to indicate by means of a mirror and scale have been tested; the errors due to after-working can be reduced to insignificance. Measurements of specific heat of gases have been made at high temperatures (600° to 800° C.). The specific heat of the simple gases is found to increase by about 3 per cent. for this interval; the results for CO_2 depart considerably from the values found by extrapolation from Regnault's formula, and also differ from those obtained by Mallard and le Chatelier from work on explosions. Measurements on steam up to 800° C. are in preparation, the water of the calorimeter being replaced by oil maintained at above 100° C. electrically. Determinations of the mean calorie in electric units are nearly completed for the range from 5° to 25° C. A calorimeter containing 10 kg. of water was used, the rise of temperature being only 1·5°. The mean calorie at 15° is found to be equal to 4·19 watt-secs., and the temperature coefficient over the range stated is — 0·0038 per degree. Work on dilatation with the Fizeau dilatometer has been carried down to liquid-air temperatures. Measurements have been made on quartz and platinum, and it appears probable that the older formula for the expansion of platinum may be safely extrapolated down to liquid-air temperatures. The viscosity of liquids has been investigated, with a view to testing the accuracy of Poiseuille's law [see Abstract No. 1540 (1905)]. Investigations on the settling of masonry have been made at the instance of Repsold, in order to obtain data for astronomical purposes; pillars built with various mortars and cements and one built without any mortar, were compared by means of delicate levels; the smallest amount of settling during the first two months was shown by the pier built with pure gypsum, the dry masonry coming next. *Electrical Section.*—The standard mercury ohm was compared with the manganin wire standards, and no trace of change in their relative values could be detected. Much work has been done on standard cells, but the difficulty arising from the mercurous sulphate remains unsolved. The suggestion to make the Weston cell the standard of e.m.f. has been opposed by the Reichsanstalt on the ground that the accuracy of standard cells has not yet reached that of the silver voltameter. Work has also been done on the polarisation of cells with solid salts. Aqueous solutions of salts containing di-valent elements have been investigated; the formula used successfully with monovalent substances is found not to apply to di-valent ones. Radium bromide was included among the salts tested, and it is found to show no special features, very closely resembling the analogous barium salt. Magnesium oxalate is found to possess anomalous properties. A magnetometer free from disturbances has been constructed and used to determine the effects of electric trams and trains in various parts of Berlin; these disturbances are becoming increasingly noticeable at the Reichsanstalt. *Radiation.*—The radiation temperature scale has been extended, and the validity of the spectro-bolometric measurements verified by a rearrangement of the carbon furnace (black body) and by varying the conditions of use and adjustment of the bolometer; constant results are obtained, in agreement with Planck's law. A list of the tests carried out in the electrical testing laboratories is given. Quadrant electrometers have been studied with regard to the effect of varying the height at which the needle hangs within the quadrants and the effects of varying potential in the needle. For the use of the electrometer in alternate-current measurements the self-induction of small standard resistances requires to be known, and this has been determined, but the work is not yet complete. Blondel's oscillograph has been studied, and most of Blondel's statements have been verified; some minor defects of the instrument were also discovered. In the department for temperature and pressure measurements the number of thermometers of all kinds sent in for testing has further increased. The limit of temperature up to which thermometers of Jena glass 59 III. can be used has been found to lie at 510° C. for prolonged exposure, but thermometers of Jena combustion tubing can be used up to 575° C. Quartz-glass thermometers intended for use at high temperatures and filled with compressed gases have been found to be dangerous owing to the risk of violent explosion. A list of photometric tests is given; these include Hefner standard lamps, osmium and Nernst lamps; also a comparison of the Carcel and pentane standards with the Hefner lamp, and tests of flicker photometers. A new method of testing the flatness of optical surfaces down to one-millionth of 1 mm. by special interference methods is described. The application of the eosin test for the durability of glasses, as applied to rough fragments, was investigated, but it is found that the test only gives satisfactory results on fractured pieces under special precautions. The durability of tubes of various glasses used as insulators in accumulators was studied.

W. Ros.

1545. *Amount of Neon and Helium in Atmospheric Air.* **W. Ramsay.** (Roy. Soc., Proc. Ser. A. 76. pp. 111–114, May 24, 1905.)—A measured quantity (18 litres) of air was treated with 100 gm. of cocoanut charcoal, cooled to — 100°, and by absorption of the oxygen and nitrogen was reduced in volume to 400 cub. cm. This volume was similarly treated in a smaller apparatus and reduced to a few cub. cm. The final traces of oxygen and nitrogen were then removed by sparking, and the inert residue, which did not show the spectrum of argon, was again treated with charcoal cooled to — 190°; in this way the helium and neon were separated. The final results were :—

Neon by weight in gaseous air	0·0000086 per cent.
„ volume „	0·0000123 „
Helium by weight „	0·00000056 „
„ volume „	0·0000040 „

A single experiment carried out in the same way showed that the amount of hydrogen present in air is probably less than $\frac{1}{500}$ of the volume of the neon and helium together, as no measurable amount of this gas was found with an apparatus accurate to this degree.

E. C. C. B.

1546. *Period of Vibration of Micro-seismic or Unfelt Earthquake Motion.* **F. Omori.** (Mathematical and Physical Soc., Tokyo, 2. 21. pp. 325–331, 1905.)—From an examination—mostly confined to the E.-W. component—of 40 earthquakes, local and distant, the author concludes that, disregarding periods smaller than 4 sec. which belong to macro-seismic vibrations, a large number of periods may be distinguished. He designates these periods now by t [formerly in Abstract No. 13 (1905) by P], and finds that $t_1 = 4{\cdot}1$ sec. $= t_2/2 = t_3/3 = t_n/n$; up to 13 periods have been distinguished. The period T_0 of the predominating movement is short in earthquakes of near origin, and longer in those of far origin, that is, T_0 lengthens with the duration of the preliminary tremor y; this is assumed to be so because vibrations of shorter period are much more rapidly reduced in size than those of slower period, so that macro-seismic vibrations are almost absent in earthquake motions proceeding from a distant origin, while the movements of different slow periods become successively prominent at the varying radial distances. It is not correct that long-period vibrations are only observed at great distances from the seismic centre; observations of local earthquakes in Japan show this. As a rule, the initial phase commences with the vibration of the longest period, and the periods decrease in succession; thus the periods of the Guatemala earthquake occurred in the order t_{10}, t_8, t_6, t_5, t_8, t_5, t_4. The mean interval J between two successive maximum movements seems to follow the formula $\tau_1\tau_2/(\tau_1-\tau_2)$, where the τ mark any two successive periods; in three cases examined the J was 1 min. 43 sec. (observed 1 min. 22 sec.), 38 (35) sec., 46 (45) sec. A superposition of vibrations of slightly different periods, giving rise to such maxima and minima groups, may be due to several causes. H. B.

1547. *Rigidity of the Earth and Velocity of Seismic Waves.* **H. Nagaoka.** (Mathematical and Physical Soc., Tokyo, 2. 22. pp. 353–356, 1905.)—The Eulerian period of the oscillation of the earth, considered as a rigid ellipsoid of rotation, would be ten months. From the variations in latitude Chandler derived the value 14 months. This prolongation has by Newcomb been ascribed to the elastic behaviour of the earth; it has further been examined by Hough, from whose deductions it would follow that the ratio: (elastic constant of the earth E)/(density of the earth ρ) should be $48{\cdot}3 \times 10^{10}\text{cm.}^2/\text{sec.}^2$. This ratio would hold for the portion lying near the surface of the earth and in the equatorial region. Supposing the earth to be composed of numerous strata of different densities and elasticities, the mean velocity of propagation for longitudinal waves should be $V_l = \sqrt{E/\rho} = 7$ km./sec., which is about the mean velocity derived from seismograms. The velocity for the transversal waves would be $V_t = \sqrt{\mu/\rho} = \sqrt{E/3\rho} = 4$ km., assuming the interior of the crust to be incompressible. Chandler's period need not, however, have any connection with seismic activity; if the seismic activity be noticeable in the motion of the pole, it will be traced in the variation of the amplitude of that motion of the pole. Surface waves seem to travel with an average velocity of 3·3 km., and their velocity should, in an incompressible elastic solid, be $0{\cdot}96\sqrt{\mu/\rho}$ according to Rayleigh. The interior would appear to be more rigid than the outside portion of the earth, and the complex nature of the variation of latitude to be connected with the complex elastic nature of the earth and with variations in barometric pressure, tidal friction, ocean currents, and other features. H. B.

1548. *Annual Variation of the Height of Sea-level at Chōshi.* **F. Omori.** (Mathematical and Physical Soc., Tokyo, 2. 21. pp. 321–322, 1905.)—Continued observations of the height of sea-level and of the barometer [see Abstracts Nos. 10 and 1183 (1905)] show that at Chōshi the sea-level was highest in Sept. and lowest in Feb., while the barometer was highest in Feb. and lowest in June to Sept. The opinion that a low barometer goes together with a high sea-level is thus confirmed. The observations were taken at 6 p.m.; monthly means are reproduced in the paper. The difference between the mean monthly maximum and minimum of the sea-level was 236 mm., corresponding to 17·4 mm. of mercury, and about three times larger than the barometric variation. The fluctuation in the height of sea-level at Chōshi is intermediate between those at Misaki and Ayukawa. Thus these three places on the Pacific show a decrease in the sea-level fluctuation as we go from south to north, just as on the coast of the Japan Sea. H. B.

1549. *Times of Occurrence of Earthquakes.* **F. Omori.** (Mathematical and Physical Soc., Tokyo, 2. 21. pp. 322–324, 1905.)—The three Kumamoto earthquakes occurred in different years, 1889 and 1894, in July or Aug., between 10.40 and 11.40 p.m.; the two Echigo earthquakes about 4 p.m., in May; the two Sanriku earthquakes on June 15, 1896 and 1901, between 5.30 and 6.30 p.m.; the two great earthquakes of North Japan about 5 p.m., but in different months. Strong earthquakes thus appear to originate in certain months at certain hours. A table of 101 large earthquakes of the north-eastern coast of the main island of Japan shows that 20 earthquakes originated in the first 6 hours of the day, 28 in the following 6, 13 in the early afternoon, 40 in the last 6 of the 24 hours. [Compare Abstract No. 2141 (1904).] H. B.

1550. *Densities of the Earth's Crust beneath the Continents and Oceans compared.* **O. Fisher.** (Cambridge Phil. Soc., Proc. 13. pp. 106–118, May 24, 1905.)—To meet criticisms by Blake (1892) and Jukes-Browne (1889), the author has resumed the calculations which he made years ago together with Brill. He assumes the earth to consist of a nucleus of concentric layers, each of uniform density, covered with a concentric shell varying from place to place in the number, density, and thickness of its layers; the normal attraction over the outer spherical surface is supposed to be uniform. Assuming, further, that the density of the continental crust increases as we pass from the upper to the lower layers and to the substratum, he arrives in his mathematical deductions at the following conclusions. The thickness of the upper layer of the continental crust is less than the depth of the ocean at any place where gravity has its average value; the density of the very thin upper layer of the sub-oceanic crust is greater than that of the lower layer. The total thickness of the continental crust is greater than the depth of the ocean together with the thickness of the sub-oceanic crust. The substratum beneath the continent has a greater density than the oceanic substratum. If there be a liquid substratum beneath the earth crust, the solid crust is thinner, but denser beneath the ocean than beneath the land. The substratum beneath the sub-oceanic crust will be affected by upward convection currents which must flow horizontally towards the continent, and descend there. The continental crust dips more deeply into the substratum, and these horizontal currents will therefore tend to compress it and to cause corrugations in it. The very thin, dense upper layer of the sub-oceanic crust may consist of basic lava from sub-oceanic volcanoes, which by oxidation would produce the red clay covering the abysmal area. The upper layer of the continental crust is thinner than the depth of the true ocean and of small density, which would agree with its sedimentary origin. Centrifugal effects are not considered. H. B.

1551. *Photography of Solar Corona on Mt. Blanc without Eclipse.* **A. Hansky.** (Comptes Rendus, 140. pp. 768–771, March 20, 1905.)—For four years the author has endeavoured to obtain photographic traces of the corona in ordinary daylight by a method based on the idea that, as the red rays of the spectrum pass through our atmosphere without sensible general absorption or dispersion, it might be possible to utilise these rays for giving the coronal image. The absorption of many colouring dyes was examined, and finally screens were made of a combination including red, orange, malachite, green, and gentian violet. Very thin films of gelatine were stained with the necessary colours and then bound together with the sensitive plate which was to take the image. On September 3, 1904, a dozen photographs were obtained with exposures varying from 30 sec. to 2 min., and various rearrangements of the screens, &c., to avoid spurious impressions due to reflected light, &c. All the photographs showed some resemblance to the solar corona as seen during eclipses, but this was only brought up by intensifications of the contrast by duplicate copying. **J. Janssen** adds a few words in favour of the appearances being real images of the corona. **H. Deslandres.** (Comptes Rendus, 140. pp. 965–970, April 10, 1905.)—Deslandres points out that it would be much more satisfactory if every precaution had been taken to eliminate scattered light, as with such a feeble light source as the corona, in comparison with the strong scattered solar light, it may be some reflected halo that has been photographed. He suggests that the occulting screen should be placed outside the apparatus at the proper distance, and then all the scattered light from the bright photosphere would never get into the telescopes. C. P. B.

1552. *Temperature Classification of Stars.* **N. Lockyer.** (Roy. Soc., Proc. Ser. A. 76. pp. 145–151, May 24, 1905.)—In a previous paper [Abstract No. 1602 (1904)] it was shown that the variation in the position of maximum intensity of the photographic spectra of stars obtained with a quartz calcite prismatic camera gave definite indications of the relative temperature conditions of the stellar atmospheres. The present paper deals with the comparison of spectra of stars having approximately similar temperatures, but on opposite sides of the curve of stellar evolution. The photographs reproduced indicate the existence of different conditions in the absorbing atmospheres of stars placed on equal horizons, while the similar extensions of the continuous spectrum shows almost identical temperatures. C. P. B.

1553. *Discovery of Saturn's Tenth Satellite.* (Nature, 72. p. 135, June 8, 1905. From Astron. Nachr., No. 4015.)—The tenth satellite of Saturn was discovered from an examination of photographs obtained with the 24-inch Bruce telescope at the Harvard College Observatory. This new satellite appears on thirteen plates, all of which were being measured for the determination of the orbit of the ninth satellite, Phœbe. Its orbital motion is direct, and the period twenty-one days, so that the body is a little nearer the planet than Hyperion. C. P. B.

REFERENCES.

1554. *Ether Drift: First, Second, and Third Order Tests.* **D. B. Brace.** (Phil. Mag. 10. pp. 71–80, July, 1905. Read in part before the Amer. Assoc. for Advancement of Science.)—This paper reviews the various experiments designed to test for the motion, if any, of the ether, and discusses the negative results of the second and third order tests so far made. A new method of experimenting has now been partially developed depending on electrical oscillations and the Kerr effect, which is considered to promise well in its present stage. [See also Abstract No. 2109 (1904).] E. H. B.

1555. *Solar Corona and Comets.* **J. F. H. Schulz.** (Phys. Zeitschr. 6. pp. 119–123, Feb. 15, 1905.)—A discussion of the appearance of the corona seen at the times of the comets of 1843 I., 1880 I., and 1882 II., and their possible physical interaction. C. P. B.

LIGHT.

1556. *New Form of Diffraction Grating Replica.* **F. E. Ives.** (Frank. Inst., Journ. 159. pp. 457–459, June, 1905.)—The Thorpe celluloid grating, though easily and cheaply made, is found to distort sufficiently to mar the definition, and the author has made an improved form from a harder and less elastic medium. Casts are made by covering the rulings on speculum metal with a solution of soluble gun-cotton in amyl acetate. After drying they are stripped off under water, placed face down on plane glass and the water dried out under pressure, leaving the lines as air spaces between film and glass. They are then sealed up under another glass, and thus protected from injury. G. E. A.

1557. *Half-shadow Analyser.* **V. Biernacki.** (Ann. d. Physik, 17. 1. pp. 180–184, June 9, 1905. Phys. Laborat. des Polytechn. Inst., Warschau, April, 1905.)—A half-shadow analyser is described which is suitable for investigating elliptically polarised light. A compensator changes the elliptical into plane polarised light, and the analyser determines the angle of polarisation. A Laurent half-wave plate covers one-half of the field of view of the analyser, the principal plane of the plate making a small angle with that of the analysing nicol. Two series of readings of the position of the analyser are given, one taken by the ordinary method, the other by the half-shadow analyser; the probable errors are ± 6·7′ and ± 0·5′ respectively. G. E. A.

1558. *Lens Testing.* **S. D. Chalmers.** (Photographic Journ. 45. pp. 143–147; Discussion, pp. 147–148, April, 1905.)—The paper gives a method of expressing the results of tests made by means of the Hartmann perforated diaphragm placed in front of the lens. Two photographs are taken on plates 15 mm. inside the focus and the same distance outside it. Additional information is obtained by exposing the various portions of the plate in succession by swinging the lens about a vertical axis through the back nodal point. The illumination was from an arc light condensed on an aperture 2 mm. diam. at a distance 9 m., and the diagrams are given which were obtained from a single achromatic lens and a well-corrected anastigmat. By recording the two diagrams for a lens alongside one another and joining corresponding points, any variation made by the lines in crossing gives the longitudinal aberrations. The lateral aberrations are measured on two superimposed diagrams of the perforated diaphragm. [See also Abstract No. 1635 (1904).] G. E. A.

1559. *Flat-wavelet Resolution.* Part III. **G. Johnstone Stoney.** (Phil. Mag. 9. pp. 577–598, April, 1905.)—After mentioning that the theorem of the resolution of light is enunciated in one of Stokes's early papers the writer proceeds to apply the theorem to the light rays in microscopes and spectroscopes. The most useful of the general conditions are stated which must be complied with in order that the resolution may be a physical one, and the properties of the medium are defined. The light passing from a cover-glass to the objective of a microscope is then the subject of [see erratum in June number] various conceptions—*e.g.*, on reversal of all the velocities in the medium taking place—the light itself would appear to pass through certain positions called standard images which would be formed according as, on removal of the stage, the medium below is imagined to be all air, oil, or one of these and cover-glass and mounting medium. The "concentration" image, viz., that seen just behind a microscope objective when the eye-piece is blank or removed, is used along with the indicator diagram [see Abstract No. 1316 (1904)] to exhibit the numerical aperture of the condenser; it also supplies useful information as to the light transmitted from the condenser to the microscopical object, and by its help the important adjustment of the distance of the source of light from the condenser can be made. The application to the spectroscope is made by means of the concentration image, the object in this case being a ruled grating. G. E. A.

1560. *Photographic Function.* **A. Guébhard.** (Soc. Franc. Phys. Séances, 1. pp. 19–33, 1905. Journ. de Physique, 4. pp. 334–348, May, 1905.) —The curve of densities in a developed negative, due to progressively increasing exposures, reaches a maximum and then falls off. The effect of a supplementary exposure may therefore be to increase, to diminish, or to leave unaffected the density, according as the original exposure corresponds to an ascending, a descending, or a horizontal part of the curve. A certain minimum exposure is necessary in order to produce any effect; if we expose an under-exposed plate to a minimum actinic radiation (say very feeble light for a short time, or a stronger light through yellow or red glass for a longer time) we may so time this supplementary exposure that the parts of the plate least affected in the camera are not even yet rendered developable, while those which have passed or nearly reached the minimum are reinforced by a continuing action, and may even be pushed over the maximum of the curve so that there may be an apparent destructive action if the supplementary exposure be prolonged. A preliminary exposure, or access of light in the camera, may have the same effect; and ripening of the film is equivalent, being due to heat instead of light. The preliminary exposures used in spectrum photography have mostly vitiated the results, the violet being much beyond its maximum, and the spectrum as a whole presenting a minimum in the violet and two wandering maxima in variable positions. When the exposure has been very prolonged the whole effect of exposure may be beyond the maximum and on the descending part of the curve; so that the developed plate is now a positive, without pure transparencies and with inferior gradations. The curve does not appear to reach zero, though it may come very near it; for exposures still more prolonged it appears to rise again as at first, most probably reaching a maximum and again descending. So far as regards the ascent to a maximum and subsequent descent to near zero, the same principles apply to development; in some developing baths (say with $Na_2S_2O_3$ in them) the maximum is soon attained and the descending slope reached, so that the product tends to be a positive; and protracted development even with weak developers may bring about the same results, in all cases after going through a stage in which the densities are approximately uniform all over the plate. The process of development is that under chemical action the effect of the exposure is continued to produce visible results; and the ultimate result is that of a summation of the effects of the exposure and the chemical action. The greater the original exposure the more promptly does the chemical action manifest itself, but the sooner does it come to a maximum. These principles account for all the apparent anomalies of exposure and development. A. D.

1561. *Three-colour Photography.* **J. Precht and E. Stenger.** (Phys. Zeitschr. 6. pp. 329–336, May 15, 1905. Phys. Inst. der techn. Hochschule, Hannover.)—The energy of radiation from a Hefner lamp being taken as 215 gm.-cals./sec.-cm^2 (Angström) at one metre distance, the radiations without a filter and through a blue, a green, and an orange filter respectively are from a Hefner lamp 215, 56, 70, and 67, and from a 32-candle electric glow-lamp 1292, 632, 832, and 739, the amount of energy being measured with a thermopile. The differences between the ratios of these numbers arise from the Hefner lamp having a large proportion of infra-red rays. The screens transmitted: blue, $\lambda = 415$ to 475; green, 515 to 575; orange, 580 to 680. For density 0·4 to 1·8, corresponding to the straight parts of the density-log. exposure curves, the amounts of radiation required per second through the blue, the green, and the orange filters respectively were 762 to 3,485, 712 to 3,649, and 896 to 4,811 ergs/cm.^{2}. The minimum measurable density was obtained with blue screen by 124 ergs per sec., white light 61 ergs per sec. The range through which the density curves were straight corresponded to a range of amounts of energy, in all cases, from 1 to 8·3; and it appears (A. König and E. Brodhun) that the logarithmic relation between stimulation and excitation (psychophysical law) holds good for a similar range from 1 : 10. With uniform development (ferrous oxalate, 18°; 2 min.) the amounts of energy required, as white light or through the green or the orange filter respectively, were for minimum darkening 4, 698, and 1,239 ergs per sec.; for density = 0·4, 38, 10,000 and 20,180 gm.-cals./sec.-cm.^{2}; for D = 0·7, 98, 22,910, and 45,710; for D = 1·0, 251, 53,700, and 102,300; the slopes of the three curves being $a = 35° 54'$, $39° 3'$, and $39° 45'$ respectively. The maximum densities in the three cases were 1·48, 1·31, and 1·40, under energies 5,400, 2,553,000, and 7,923,000 respectively; and solarisation began, again in the same three cases, under energies 1,979 304,500, and 270,000, all three $\times 10^3$, ergs per sec. respectively. Undyed emulsions follow the same laws but require larger amounts of energy to produce the same effects. The problem of three-colour photography is to obtain results proportionate to those given by the eye as a sensitive instrument. AgBr-gelatine has in any event a maximum of sensibility at $\lambda = 465$, and the blue filter utilises this; the green and the orange filters utilise maxima of sensibility which are introduced by and depend upon the particular sensitising dye-stuffs employed. Perchromo plates (used throughout these experiments) have such maxima at $\lambda = 580$ (stronger) and $\lambda = 530$ (weaker). Then in order to reproduce white from a single source of light these three maxima must come up to equal densities, and this involves an adjustment of relative exposures depending on the screens and on the sensitivities of the plate. But such an adjustment made for one kind of light is defective for another; a ratio of blue 1 : green 3 : orange 9 for bright sunshine becomes one of 1 : 6 : 25 for gloomy weather; and there is as yet no simple instrument for ascertaining such variations in the ratio of exposures. For light-waves which have traversed the respective three screens, the density curves are similar to those obtained under white light and, for their straight portions, are on the whole parallel to one another, the green tending to ascend less steeply than the others; and all three ascend more and more gradually to a maximum. The human eye shows precisely analogous phenomena, but the ascent of the curve is more gentle; whence three-colour processes apparently tend to exaggerate the colour contrasts of nature. Ferrous oxalate at 18° for 3 min. brings out the minimum darkening, and anything beyond 3 min. merely increases fog; but with plates exposed under green or yellow screens development protracted beyond 3 min. may increase the density by, say, from 25 to

55 per cent. The effect of the sensitising dye-stuffs is solely to shorten the exposures requisite for yellow and orange; identical results can be obtained with undyed plates under longer exposures for these colours. The best modern dye-stuffs increases sensibility at $\lambda = 600$, but the sensitiveness falls off rapidly on each side of this value; the human eye has a maximum sensibility at $\lambda = 660$, and what is wanted for true photographic renderings is a sensitiser which will give a maximum sensitiveness at about $\lambda = 650$.

A. D.

1562. *Generation and Transformation of Light.* **A. Einstein.** (Ann. d. Physik, 17. 1. pp. 132–148, June 9, 1905.)—A discussion of optical phenomena from the electromagnetic standpoint, but in which the medium concerned is treated as discontinuous instead of, as usual in Maxwell's theory, a continuous function of the space coordinates. It is urged that such phenomena as black radiation, photoluminescence, the generation of kathode rays by ultra-violet light and other kindred transformations, may be better understood on the assumption that the energy of light is distributed discontinuously throughout space. Thus, according to this view, the radiation of light from a point is to be thought of, not as continuously distributed over greater and greater spaces, but as consisting of a finite number of quantities of energy located in points of space, which quantities cannot be divided but are as complete wholes generated and absorbed.

E. H. B.

1563. *Pressure of Waves Radiating on the Surface of a Liquid.* **N. Kapzov.** (Ann. d. Physik, 17. 1. pp. 64–77, June 9, 1905. Phys. Inst. d. Univ., Moskau, March, 1905.)—Rayleigh established theoretically that a body which disturbed the free radiation of an oscillatory motion was itself acted upon by a pressure independent of the physical nature of that wave motion, but equal to its energy density at the place in question. [See Abstract No. 1495 (1902).] These theoretical conclusions have been experimentally confirmed by Lebedew [see Abstract No. 834 (1902)], also by Nichols and Hull [see Abstract No. 1690 (1902)] for the pressure of light on various surfaces, and by Altberg for the pressure of sound waves on a reflecting surface [see Abstract No. 1471 (1904)]. The present author, under Lebedew, attacks the corresponding experimental confirmation for waves on the surface of a liquid. A tank 200 × 200 × 7·5 cm. is used, the depth of water being 5·5 cm. To set up the waves a lath about 200 × 10 cm. is almost immersed in the water edgewise. It hangs from the top of a firm standard and is moved to and fro horizontally at right angles to its length by a rod which connects it to the crank-pin of a wheel kept in continuous rotation. To avoid the undesirable reflection of these waves, sloping sides are fitted to the tank, the angle being arranged so as to entirely absorb the incident waves, in the manner of a sea beach. To receive the waves and experience their pressure a movable piece is used, placed between other pieces whose presence eliminates the disturbance of the end phenomena. The energy in the incident waves is calculated and their pressure detected and measured by the swing of the movable piece which is suspended. The result is in agreement with Rayleigh's theoretical conclusions within the limits of experimental errors; the ratios of measured and expected pressures being in three cases 1·16, 1·17, and 0·98 respectively.

E. H. B.

1564. *Radiation-Pressure on Clear Glass.* **G. F. Hull.** (Nature, 72. pp. 198–199, June 29, 1905.)—Since the appearance of a paper on "The

Elimination of Gas Action in Experiments on Light-Pressure" [Abstract No. 1378 (1905)] the author has learned that there is a difference of views among mathematical physicists concerning the pressure of radiation on a non-absorbing medium. On this account he here gathers together the original data in order to compare the light-pressure upon a vane of clear glass with that upon a silvered surface. The experiment may be here recalled. A torsion balance carrying a thin vertical glass vane, 14 × 10 × 0·1 mm., silvered on one side, was suspended in a bell-jar, and the air was pumped out until the pressure was about 40 mm. of mercury. A beam of light was thrown upon this vane at a definite distance from the rotation axis, and, by turns, on each side of it. The deflections were read by a telescope and scale. A Nernst lamp was used as a source, the intensity being given by a precision wattmeter. The balance was then turned through 180° by the rotation of the external control magnet, and readings were again taken. The mean was proportional to the pressure of the incident and reflected beam. The mean reflection coefficient of air-silver and air-glass-silver for the radiation used has been found to be 85 per cent. The pressure, according to Maxwell's theory, should therefore be 1·85 times that due to the incident beam. The throw obtained (containing certainly less than 1 per cent. of gas action) was 22·8 divisions. Hence the pressure of the standard beam upon a black surface would be calculated to give a deflection of 22·8 ÷ 1·85, or 12·4 divisions. The balance was then taken from the bell-jar, the silver removed from the vane, the balance replaced, and the exhaustion carried out as before. The mean throw obtained for 40 observations with the standard lamp was 2·1 divisions. The normal reflection coefficient of glass ($\mu = 1{\cdot}52$) for this kind of radiation is 4·1 per cent. The amount reflected from the two surfaces is then taken as approximately 8·2 per cent. Hence the energy density in front of the glass is about 1·082 times that of the incident beam, and that behind the vane is about 0·918 times. Thus the former exceeds the latter by 16·4 per cent., or 0·164 of the energy density of the incident beam. Assuming that the pressures on the front and back surfaces of the glass are proportional to the energy densities, then the pressure of the standard beam upon a black surface would be represented by 2·1 ÷ 0·164, or 12·7 divisions. The agreement between these two results (12·4 and 12·7) is held to show that light passing through a plate of glass exerts pressures upon the surfaces equal to the difference between the energy densities in front of and behind these surfaces. E. H. B.

1565. *Emission Spectra of Metals in the Electric Furnace.* **A. S. King.** (Ann. d. Physik, 16. 2. pp. 360–381, Feb. 24, 1905. Phys. Inst., Bonn, Oct., 1904. Astrophys. Journ. 21. pp. 236–257, April, 1905.)—Using an electric furnace of similar form to that of Liveing and Dewar, with an arc of about 30 amps., and a photographic concave Rowland grating of 1 m. radius, a series of spectra were obtained showing strong emission spectra of various substances at an exceedingly high temperature, estimated at about 2,500° abs. The chief results obtained may be summarised as follows: (1) The electric furnace produces emission spectra containing numerous lines whose relative intensities are very different from the lines of the arc spectrum. (2) The method is specially favourable for the production of banded spectra. (3) The changes in intensity of the Cæsium Series lines with the temperature points to an effect by altered electric action similar to that of changed temperature. (4) The calcium spectrum from the furnace shows: (*a*) great sensitiveness to slight changes of temperature; (*b*) a peculiar behaviour of the H and K lines, which appear only at maximum temperature and then very weak; (*c*) *g* shows an unsymmetrical broadening of reversal, giving an apparent displacement; (*d*) using the vapour in the furnace as absorbing medium showed the absorption of *g* to be much greater than that of other calcium lines and to vary with the temperature of the furnace. (5) The pairs of homologous lines in the spectra of Ca, Sr, and Ba, belonging to the same metallic type, are in each case much weakened in the furnace spectrum as compared to the arc. (6) The furnace spectrum shows new groups of bands in the spectra of Ca, Sr, Ba, and Cu. The structure of the green band group of Ba seems to result from a shift of maximum intensity through the successive bands of the group. (7) The relative intensities of Cu lines given by the furnace approach those of the very weak arc. The absence of the ultra-violet pairs speaks for temperature as the chief agent in producing the spectrum. (8) In many cases a very small amount of a substance in the furnace served to give characteristic lines. (9) It was shown incidentally that ionised vapour direct from the arc, when confined, would give the arc spectrum, though out of the path of the current. (10) Water vapour in the furnace had the effect of intensifying certain metallic lines. [See also Abstracts Nos. 1927, 2600, 2885 (1904).] C. P. B.

1566. *Application of Interferential Spectroscopy to Solar Spectrum.* **C. Fabry.** (Comptes Rendus, 140. pp. 1186–1189, April 25, 1905.)—A description of a new arrangement of the author's well-known interferential spectroscope to the investigation of any spectra consisting of a continuous background with dark absorption lines. Using the silvered interference plates in conjunction with a slit spectrograph, the spectrum is formed of the intersection of the interference rings given by the plates and the images of the slit, showing a succession of alternate bright and dark points. By measuring the distance between any symmetrical pair of these points on any particular line of the solar spectrum, the wave-length of the line can be determined. C. P. B.

1567. *Ultra-violet Absorption Spectra of Certain Enol-keto-tautomerides.* Part II. **E. C. C. Baly** and **C. H. Desch.** (Chem. Soc., Journ. 87. pp. 766–784, May, 1905.)—The conclusions drawn in the first part [see Abstract No. 2547 (1904)] from an investigation of the ultra-violet spectra of acetyl acetone and ethyl acetoacetate and of certain derivatives of these compounds have now been confirmed by a similar investigation of benzoylacetone and its aluminium derivative, ethyl benzoylsuccinate, ethyl acetylsuccinate, ethyl diacetylsuccinate, ethyl benzoylacetate and its aluminium derivative, ethyl oxaloacetate, ethyl acetonedicarboxylate, and certain other compounds; the results give additional support to the view that the absorption band is due to the change of linking taking place when one tautomeric form passes into the other, and the formation of the band may be explained by the modern physical conception of the atom as a system of electrons. The labile atom may be regarded as a potential ion, inasmuch as the bond of attraction or Faraday tube of force must be considered to be lengthened sufficiently to allow of the interchange of the atom from the one position to the other within the molecule; the action of alkali and acid (of which the former tends, up to a certain maximum, to increase the persistence of the ultra-violet absorption band, whilst the latter tends to decrease it) may thus be considered to have the effect of lengthening or shortening these tubes of force, thereby increasing or diminishing the number of interchanges taking place in unit time. Similarly, in the case of salts in solution, it may be considered that the dissolved salts are not dissociated into independent ions, but that the two parts of the molecule are merely drawn apart to a certain extent by the action of the solvent; when the two parts are sufficiently separated to allow of the interchange of parts between adjacent molecules, then the condition known as ionisation occurs. It should be mentioned that the conclusions of the authors are based on experiments in which the substances were in dilute solutions, of concentrations from N/100 to N/1000. D. H. J.

1568. *Arc Spectrum of Manganese.* **C. Fritsch.** (Ann. d. Physik, 16. 5. pp. 793–837, May 16, 1905.)—This paper contains the wave-lengths of the lines in the arc spectrum of manganese between the limits $\lambda = 5748$ and $\lambda = 2346$. The measurements are based partly upon Kayser's normals in the iron spectrum and partly upon Fabry and Perot's standards. The ratio of the wave-length of the D_1 line used by Rowland to that found by Fabry and Perot is 1·00003799; the author has multiplied certain of Fabry and Perot's values for iron lines by this ratio and interpolated his measurements between these new values where possible. For the rest he has interpolated between certain of Kayser's standards. The standard lines he used are all given, and, further, the coincidence method was not used. In this way his results can at any time be reduced to the new standard when this has been definitely agreed upon. E. C. C. B.

1569. *Spectrum of Silicon and of Fluorine.* **J. Lunt.** (Roy. Soc., Proc. Ser. A. 76. pp. 118–126, May 24, 1905.)—Lockyer and Baxandall [see Abstract No. 347 (1905)] recently brought forward some further evidence that the three lines at $\lambda = 4089{\cdot}1$, $\lambda = 4096{\cdot}9$, and $\lambda = 4116{\cdot}4$ are due to silicon, doubt having been thrown upon this by de Gramont. The author supports the view that the first and third lines are due to silicon but not the second. He says that Lockyer and Baxandall's observations upon the vacuum-tube spectra of silicon tetrafluoride are vitiated by the fact that the lines they observed undoubtedly came from the glass walls of the tube. This was clearly the case, as oxygen lines are visible on their photographs. If the spectra be observed of sparks between pure silicate electrodes in air, then the first and third lines are clearly visible but not the second; the origin of this line must be found elsewhere. The author further points out that the fluorine lines can readily be picked out of the vacuum-tube spectrum of silicon tetrafluoride on account of their different appearance. He gives their wave-lengths as follows:—

	λ.	Intensity.		λ.	Intensity.	λ.	Intensity.
1st Triplet	3847·3	3		4025·3	10	4246·5	30
	3850·3	2		4084·1	2	4299·3	7
	3851·8	1	Group of five lines	4103·6	10	4446·8	20
2nd Triplet	3899·0	2		4109·3	5		
	3902·1	1		4113·0	2		
	3904·0	<1		4116·8	2		
				4119·3	3		

E. C. C. B.

1570. *Infra-red Absorption Spectra.* II. **W. W. Coblentz.** (Phys. Rev. 20. pp. 337–363, June, 1905.)—A continuation of the work upon the infra-red absorption spectra of organic compounds [see Abstract No. 1418 (1905)] up to the limit of $\lambda = 15\mu$. It is shown how the absorption depends very largely upon the arrangement or linking of the atoms in the molecule; for example, the following groups when present generally give rise to characteristic bands:

CH_2 or CH_3, NH_2, C_6H_5, NO_2, OH, NCS. Again, the carbohydrates have all very similar spectra, and in fine there seems very little reason to doubt that the bands are due to characteristic groupings of atoms, and when more than one such group is present the resulting absorptions are superposed.

E. C. C. B.

1571. *Light Emitted by Crystalline Arsenious Oxide.* **D. Gernez.** (Comptes Rendus, 140. pp. 1134–1136, April 25, 1905.)—A study of the light emitted when vitreous arsenious oxide is dissolved in a mixture of equal parts of fuming hydrochloric acid and water, the solution boiled, then gently cooled and octahedral arsenious oxide crystallised out, has proved that (1) emission of light does not occur at the moment of crystallisation, but is produced by collision of the crystals or by contact with a hard body, *e.g.*, a rod of steel, silver, or platinum, and may therefore be regarded as a result of the rupture of the crystals; (2) it is unnecessary to boil the solution, the temperature of 40° reached when the oxide is dissolved in the mixture of hydrochloric acid and water, both initially at the ordinary temperature, being sufficient; (3) this property of the crystals is not fugitive, but remains for a very long time; and (4) the use of the vitreous modification is not essential for the occurrence of the phenomenon, the same result being obtained by dissolving powdered crystals of the oxide in the mixture of acid and water.

W. H. Si.

1572. *Triboluminescence of Arsenious Acid.* **J. Guinchant.** (Comptes Rendus, 140. pp. 1170–1171, May 1, 1905. Abstract. Journ. de Physique, 4. pp. 413–417, June, 1905.)—The luminescence of arsenious acid is due to the rupture and transformation of its crystals after their formation. The light produced gives a continuous visible spectrum which contains the red, but in which the green and yellow rays predominate. The radiations have great photochemical power, and the action on a photographic plate of the crystals a few cm. away is comparable with that of a Bunsen burner at a distance of 1 m. The triboluminescence of the crystals, either isolated or during formation in a solution, produces no action on an electroscope. When urea acts upon a moderately concentrated solution of a hypochlorite or hypobromite, vivid luminescence occurs. The same phenomenon, in varying degrees of intensity, is observed with oxamide, uric acid, ammonium thiocyanate, ammonia, and asparagine (slight). The cause of this emission is shown to be the production and immediate decomposition of nitrogen chloride. The light emitted has no special properties and is very poor in photochemical rays. A concentrated solution of sodium hypobromite also exhibits luminescence when a few pieces of sodium amalgam are thrown into it, the bubbles of hydrogen evolved being surrounded by a luminous zone; the principal part in producing the luminescence is probably played by the particles of the amalgam carried away by the gas evolved. T. H. P.

1573. *Fluorescence and Absorption.* **J. B. Burke.** (Roy. Soc., Proc. Ser. A. 76. pp. 165–167, May 24, 1905.)—After referring to his former paper on the change of absorption produced by fluorescence [see Abstract No. 1350 (1899)] and to that of Nichols and Merritt [Abstract No. 581 (1905)], the author calls attention to a paper by Camichel [see Abstract No. 1002 (1905)]. While the author of this note measured the absorption by a fluorescing body, of light transmitted from another body also in a state of fluorescence, and Nichols and Merritt observed the same effect when the source of the transmitted light was an acetylene flame, Camichel, on the other hand, obtained a negative result. This the author considers to have been due partly to feebleness of fluorescence and partly to the fact that the precaution taken by Camichel of using a fluorescent screen 7 cm. in thickness to cut off the more refrangible rays from the flame ought also to stop the greater portion of the rays, the absorption of which, by another and similar body, it is desired to detect. Moreover, the fluorescent spectrum of uranium glass (the substance used as a screen), is composed of several bands, and these probably not continuous but made up of finely divided smaller bands or lines. If, therefore, by any means the light of precisely the same period as the fluorescent light be sifted, or removed, from the spectrum of the light transmitted through uranium glass, it is not to be expected that variations in the absorption corresponding to the changes in the body during the fluorescent state should occur. J. J. S.

1574. *Triboluminescence of Potassium Sulphate.* **D. Gernez.** (Comptes Rendus, 140. pp. 1234–1236, May 8, 1905.)—The author shows that the triboluminescence of potassium sulphate is produced, not at the instant when the dissolved salt crystallises out from its combination with sodium sulphate, but on the rupture of the crystals already formed either against one another or against the walls of the vessel. Crystals of potassium sulphate of very varied origins all become luminescent when broken, no difference being observed between crystals obtained by dissolving previously fused potassium sulphate and crystals obtained from the non-fused salt. T. H. P.

1575. *Crystallo-luminescence and Triboluminescence.* **M. Trautz** and **P. Schorigin.** (Zeitschr. Elektrochem. 11. pp. 306–307, May 26, 1905. Extract from Zeitschr. Wiss. Phot. 3. 2. pp. 80–90, 1905.)—Besides permanent triboluminescence, temporary phenomena of this kind are frequently met with, and these are generally stronger than the former. Triboluminescence consists of sparks which traverse the crystal like lightning in certain directions. Crystallo-luminescence and triboluminescence are met with together; the former property is exhibited in increasing degree by the following series of compounds:—

As_2O_3, cresol carbonate, $Sr(BrO_3)_2 . H_2O$, $Ba(BrO_3)_2 . H_2O$, $Ba(ClO_3)_2 . H_2O$, $NaBrO_3$, $2K_2SO_4 . Na_2SO_4$, K_2SO_4, $Ca(BrO_3)_2 . H_2O$, NaF, $Mg(BrO_3)_2 . 6H_2O$.

Crystallo-luminescence is probably a form of triboluminescence produced by mechanical motions in the liquid. The light is bluish-white, and acts on a photographic plate, but not on an electroscope. T. H. P.

1576. *Action of Hydrogen Peroxide on a Photographic Plate.* **C. Otsuki.** (Soc. Chem. Ind., Journ. 24. pp. 575–582; Discussion, pp. 582–583, June 15, 1905.)—The action of hydrogen peroxide on a photographic plate in the dark has recently been considered by Graetz to be a radiation from this substance. The author describes his experimental investigation of this question, and considers the nature of the action of the peroxide on a photographic plate. The following are his conclusions: (1) So far as the propagation in a straight line and penetration through metals are considered as indicating a radiation, the action of hydrogen peroxide on a photographic plate cannot be considered as a radiation of this substance. (2) Gelatine, celluloid, paper, soft gums, Canada balsam, allow the action of hydrogen peroxide to pass through;

ebonite, glass, metals, paraffin, fish-membrane do not. This agrees with Russell's results. (3) The reaction between hydrogen peroxide and silver bromide gelatine depends upon the temperature. This great sensibility to temperature causes the phenomenon called "border effect." (4) With the same degree of concentration of the peroxide solution the photographic effect increases with increase of the time of exposure. Beyond the maximum a phenomenon similar to solarisation takes place. (5) The effect of hydrogen peroxide on a photographic plate is due to the change in the bromide of silver contained in the sensitive layer of the plate. Silver bromide under the action of the peroxide changes most probably to a lower bromide of silver, which is easily reduced by the developer. The latent image produced by hydrogen peroxide consists of this lower bromide of silver, and can be destroyed by bromination. [See also next Abstract.] J. J. S.

1577. *Development of Photographic Plates.* **C. Otsuki.** (Soc. Chem. Ind., Journ. 24. pp. 583–585, June 15, 1905.)—The author has investigated the influence of the length of the time of development on the degree of darkening of the photographic plate, and states the following exponential law of development: (1) Within the range of the normal exposures, neutral zone inclusive, the density ratio for any two lengths of time of development is constant and independent of exposure. (2) The density at a constant exposure is proportional to a certain power of the length of time of development. (3) The density at any exposure for the length of time of development $2^n T$ seconds is equal to that of T seconds at the corresponding exposure multiplied by C, where C is a constant. J. J. S.

1578. *Radiotellurium.* **W. Marckwald.** (Ber. Deut. Chem. Gesell. 38. pp. 591–594, Feb. 11, 1905. Chem. News, 91. pp. 121–122, March 17, 1905.)—The crude tellurium obtained from 15 tons of pitch blende was treated by the method previously described by the author, and the product purified, 3 mgm. of a very radio-active material being obtained. The rate of decay was such that the intensity sank to half value in 139·8 days. Radiotellurium is held not to be identical with polonium, the decay rate of which is different, nor with Rutherford's Radium E [see Abstract No. 81 (1905)]. L. H. W.

1579. *Decay of Radio-activity.* **S. Meyer** and **E. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 387–395, March and April, 1905. From the Inst. f. theoret. Physik and the II. Phys. Inst. der k.k. Univ., Wien.)—The authors have previously found an abnormal rate of decay for UrX. [See Abstract No. 533 (1905).] The experiments now repeated in the present paper do not support the earlier ones. It is shown also by experiment that the presence of activity due to thorium does not affect the rate of decay of activity due to radium. The rate of decay of radio-tellurium is investigated; it is found to follow an exponential law falling to half value in 135 days. Hoffmann's radio-lead is found to have exactly the same constant. It is worth notice, on account of Rutherford's view, that these two substances and RaE are identical, that he gives 150 days for the constant of the last substance. R. S. W.

1580. *Ionisation of Air contained in a Closed Metallic Cylinder and the Radio-activity of Some Metals.* **J. J. Borgmann.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, (Physical Part), 37. No. 4. pp. 77–98, 1905.)—During a period of 8 months the author made experiments on the ionisation of air contained in cylinders of different metals; the method was the same as in earlier work by the author. The experiments lead to the following conclusions: (1) The ionisation of the air depends on the nature of the metallic cylinder in which the air is enclosed. (2) In a cylinder of coke, copper, brass, or iron, the ionisation is greater during the inflow of fresh air than it is immediately afterwards. (3) The ionisation of the air in a cylinder of copper, aluminium, brass, iron, zinc, tin, or lead increases for some days in a continuous manner until it reaches a limit. This limit is different for different metals, and was not found to remain constant; it varies from one day to another as well as during a single day. The minimum of ionisation was most often observed about 3 p.m. (4) The ionisation of the air enclosed in a metallic cylinder shows from time to time variation in two senses—sometimes augmentation, sometimes diminution. (5) The presence, for some days, of a lead cylinder within a brass cylinder produces an induced radioactivity of short duration (some minutes) on the surface of the brass cylinder. (6) The increase of the ionisation up to a limiting value for each metal may be attributed to the action of the emanations given off by the metals. Lead possesses in the highest degree the property of emitting the emanation; the other metals may be arranged in the following order: zinc, tin, iron, brass, aluminium, and copper. The following table shows the maximum values for the ionisation of air in the interior of cylinders of the same dimensions but of different materials. These values are expressed in terms of the number of electrometer scale-divisions traversed by the needle in 1 min. The third column contains the number (*n*) of ions (positive or negative) produced during 1 sec. in each cub. cm. of air:—

Material of the Cylinder.	Maximum Ionisation.	*n*.
Oxidised copper	2·4	76
Galvanoplastic copper	3·8	120
Aluminium	3·9	123
Brass	4·5	143
Iron	5·25	166
Tin......................................	5·4	170
Zinc	6·7	218
Lead (No. 2)	23·0	726
Lead (No. 3)	15·35	485

D. H. J.

1581. *Radium and Photographic Plates.* **J. Petri.** (Ann. d. Physik, 16. 5. pp. 951–957, May 16, 1905.)—Certain peculiar deformations of the shadows of coins of different metals laid on a photographic plate and exposed to radium emanation in a magnetic field are described; the shadows appear deformed as if the gaps between the coins were bridged over. The simultaneous action of a magnetic field and of thermoelectric currents seemed necessary. The author attributes the phenomenon to a sorting out and redistribution of the α, β, and γ emanations from the radium bromide. A. D.

1582. *Excited Activity due to γ-Rays.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 13. p. 124, May 24, 1905.)—Experiments have been made to see if the radiation given out by metals could be temporarily increased by exposure to the radiations from radium. The saturation current inside a closed metallic vessel is measured, and then a closed capsule of radium is introduced. This is left for a period varying from 1 hour to several days. It is removed, and the saturation current again measured as quickly as possible. No increase can be detected. **H. A. Bumstead.** (Cambridge Phil. Soc., Proc. 13. pp. 125–128, May 24, 1905.)—In J. J. Thomson's experiments 5 minutes elapsed before the saturation current could be measured after the removal of the radium. The experiments here described are so arranged that only a very small fraction of a second passes between exposure and test. A horizontal metal disc rotates rapidly on a vertical axis, and above it is placed the radium. There is also a metal cylinder above the plate, and any radiations excited in the latter would be shot into this and so cause ionisation. The amount of this can be tested with an electroscope. Again no excited activity could be detected. R. S. W.

1583. *Charge Carried by γ-Rays.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 13. pp. 121–123, May 24, 1905.)—Paschen's results on this subject can be ascribed to the presence of secondary radiations excited at the surface of the material of which the apparatus is composed. Thus when radium is enclosed in an insulated thick lead box which does not absorb all the γ-rays, at the point where the rays pass out there is secondary radiation, which, like β-rays, consists of negatively-charged particles. The lead, therefore, loses negative electricity, as Paschen found. In another experiment an insulated conductor was placed in a highly evacuated bulb and γ-rays allowed to fall on it. But to do this the rays have to pass through the glass, and here give rise to secondary rays which charge the conductor negatively. This again is Paschen's result. The author arranges two metal cylinders in electrical communication with each other and with an electroscope, all in a highly exhausted space. Cylinder A is hollow, B is filled with lead. They are charged (1) positively, (2) negatively, and the leak observed (*a*) when the γ-rays pass through A and (*b*) through B. If l_1 is the leak with positive charge and l_2 with negative, then $\frac{1}{2}(l_1 + l_2)$ is the leak due to defective insulation, and $\frac{1}{2}(l_1 - l_2)$ due to the rays. If the rays carry a negative charge, since they are absorbed by the lead, the quantity $\frac{1}{2}(l_1 - l_2)$ should be greater when they pass through B than through A; while if the leak is due to secondary radiation, this will take place at the points of entrance and exit for A, but only at entrance for B since they are absorbed by the lead; $\frac{1}{2}(l_1 - l_2)$ should therefore be the greater for A in this case. This the experiments show is the case, and that the electricity escaping is negative. Paschen's results are therefore due to secondary rays, and the charge of the γ-rays has not yet been demonstrated. R. S. W.

1584. *Radio-active Minerals.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 76. pp. 88–101, May 24; and p. 312, July 10, 1905.)—The study of radio-active minerals is one of the most promising methods of attacking the problem of the connection between the radio-active elements and the nature of the ultimate products of their change. The present paper deals with the amount of uranium, radium, thorium, and helium in the minerals. The uranium is obtained by the ordinary methods of analysis. The radium is determined by means of its emanation. A known weight of the mineral is decomposed by fusion with borax and dissolved in dilute HCl. It is boiled to expel any emanation, and then the amount that collects in one day is estimated by the usual electroscopic methods. Comparison is made with a solution of radium bromide of known strength to reduce the measurements to absolute value. Thorium is also determined by its emanation; air is bubbled through a solution and is carried past an electroscope. Radium emanation is at first present if the solution has been standing, but afterwards is not produced fast enough to affect the readings. Absolute measurements are obtained as for radium. Helium is determined by Travers' method. The ratio of uranium to radium is found to vary very little for the different minerals except for pyro-morphite. Uranium is found in several minerals, *e.g.*, monazite, which have previously been thought free from it. Thorium is invariably accompanied by the uranium-radium association, although the ratio varies in wide limits. It may be that Th gives rise to Ur, the difference in the ratio arising from the slowness of the change. It is worthy of note that one of the cerium metals is frequently found with thorium. In no case is any mineral found to contain more than a trace of helium, unless it contains thorium also; but it does not follow that minerals rich in thorium will contain much helium. This does not weaken the view that Th produces He, for the conditions may not have been favourable for the retention of the gas when formed. Helium may also be plentiful where radium is scarce. It is therefore concluded that the gas is produced in minerals more by thorium than radium. R. S. W.

1585. *Production of Radium from Uranium.* **F. Soddy.** (Phil. Mag. 9. pp. 768–779, June 1905.)—1 kg. of uranium nitrate is dissolved in water, H_2SO_4 added, and then successive quantities of barium nitrate solution, filtering following each addition. The solution is enclosed in a bottle and air drawn through; testing by an electroscope shows that the solution is practically free from radium. This test has been repeated over a period of eighteen months, showing a gradual growth of radium in the solution. The amount of radium produced is only 1/1000th of the amount that should be produced on the assumption of a direct change from UrX into radium. Any intermediate products whose life is long compared with the time of the experiments would account for this. Reasons are given for supposing that either bismuth or lead are the final products of the radio-active changes. R. S. W.

1586. *Effect of Temperature on the Rate of Decay of Radium.* **H. L. Bronson.** (Amer. Journ. Sci. 20. pp. 60–64, July, 1905.)—Curie and Danne have come to the conclusion that a temperature 630°–1,300° has a permanent effect on the rate of decay of the active deposit from radium [see Abstract No. 1360 (1904).] As the result of his own experiments the author comes to the opposite conclusion. He also thinks that the decay periods of 28 and 21 min. for radium B and C are too long, and that 26 and 19 min. are nearly right. R. S. W.

1587. *Proportion of Radium and Uranium in Minerals.* **E. Rutherford** and **B. B. Boltwood.** (Amer. Journ. Sci. 20. pp. 55–56, July, 1905. Chem. News, 92. pp. 38–39, July 28, 1905.)—It has been shown by both Boltwood and Strutt that the proportion of radium to uranium in radio-active minerals is constant. The authors now seek to determine the weight of radium in radio-active equilibrium with 1 gm. of uranium, and find it equal to $7{\cdot}4 \times 10^{-7}$ gm. This is obtained by comparing the quantity of emanation obtainable from a mineral of known uranium content with that from a solution of the purest radium bromide obtainable. This amount is about that to be expected if uranium is the parent of radium. R. S. W.

1588. *Actinium and its Products.* **T. Godlewski.** (Phil. Mag. 10. pp. 35–45, July, 1905. Paper read before the Acad. of Sciences in Cracow, April 3, 1905.)—This paper makes considerable additions to our knowledge of actinium. A solution containing 0·15 gm. of Giesel's emanating substance, which has been shown to be the same as actinium, is made in weak HCl. Ammonia is added and a reddish-brown precipitate is formed. This is dried quickly and its activity measured; at first it is nearly inactive, but gradually recovers its activity, as does thorium under similar circumstances. The filtrate is evaporated to dryness and the residue ignited. The substance remaining is about one hundred times as active, weight for weight, as the original actinium [see Abstract No. 744 (1905).] Its activity at first increases, then decreases according to an exponential law, falling to half value in 10·2 days. This substance, after analogy with thorium, is called actinium X (AcX). The decay and recovery curves are similar to those of thorium, except that the latter does not show any initial decay. This is due to the substance causing the excited activity being soluble in ammonia, and readily volatile in the case of actinium, while the corresponding thorium product is insoluble and less readily volatile. It seems probable that actinium quite free from AcX would be altogether devoid of activity, *i.e.*, the change of Ac into AcX is a rayless change. AcX gives out α, β, and γ-rays, and special experiments show that AcX is the source of Ac emanation. A diagram is given showing the complete analogy between Th and Ac as regards the successive products formed, but the different rates of decay point conclusively to the fact that in actinium we have a distinct chemical element. The β-rays of actinium are completely distinct from those emitted by other radio-elements, in that they are homogeneous. This is established by absorption measurements; the equation $I = I_0 e^{-\lambda d}$ is applicable even when I is less than 1 per cent. of its original value. The absorption constant is about 2·5 times greater than for uranium. The γ-rays are also fairly homogeneous; their penetrating power is about one-quarter that observed for the γ-rays of radium. R. S. W.

1589. *Properties of the α-Rays for Radium.* **E. Rutherford.** (Phil. Mag. 10. pp. 163–176, July, 1905.)—The paper contains the preliminary results of experiments made to determine the velocity and the ratio e/m for α-rays. The magnetic deflection of a homogeneous pencil has been measured, but the author has not yet been able to observe accurately the deviation produced by an electrostatic field. Bragg and Kleeman have shown that the α-rays from radium consist of four distinct sets, each homogeneous, and that, in particular, the α-rays from radium C cease to ionise air after passing through 6·7 cm. at atmospheric pressure. Also it is known that the effect of radium A is negligible after it has been deposited 15 min., while radium B gives out no rays at all. Hence, if a wire be rendered active by exposure to emanation, after 15 min. there will be a homogeneous pencil of α-rays due to radium C alone. It is such a wire that is used as source. A deflection on the photographic plate of over 4 mm. can be obtained. The value of $H\rho = 3{\cdot}98 \times 10^5 = mV/e$, where H = field strength, ρ = radius of curvature of path. Another equation is obtained from the heating effect. The radium C in 1 gm. of radium emits 31 gm.-cals. per hour [Abstract No. 1085 (1904)]. Hence $\frac{1}{2} mnV^2 = 3{\cdot}6 \times 10^5$ ergs, and n the number of α-particles emitted per sec. $= 6{\cdot}2 \times 10^{10}$. Hence, since ρ is found $= 42$ cm., $V = 2{\cdot}6 \times 10^9$ cm. per sec., and $e/m = 6{\cdot}5 \times 10^3$ electromagnetic units. The valve of n is, however, somewhat uncertain. The ionising, photographic, and phosphorescence exciting action all cease very abruptly after passing through 13 layers of aluminium-foil, which are equivalent to 6·7 cm. of air as far as quantity of matter is in question. By measuring the magnetic deflection after passing through different layers, it is found that the α-particles have lost about 40 per cent. of their kinetic energy, when they cease to ionise, &c. Knowing the velocity of the α-particles expelled from radium C, the velocity of those expelled from other radio-active products can be deduced, provided the maximum range of their ionisation in air is known. Bragg and Kleeman have determined the latter. It seems probable that the photographic effect, as well as the phosphorescent action, are due to the same cause, viz., ionisation. Becquerel supposes the latter due to cleavage of the crystals. Since the α-particles are incapable of producing an effect by which they can be detected if their velocity falls below a certain critical value, it is possible that the various rayless changes known to occur may cause emission of particles whose velocity is below this value. This consideration has an important bearing on the question of whether matter in general is radioactive. It is possible that all matter may be emitting particles at a much greater rate than uranium, without producing appreciable electrical action.

R. S. W.

1590. *Uranium Radio-activity.* **T. Godlewski.** (Phil. Mag. 10. pp. 45–60, July, 1905. Paper read before the Acad. of Sciences in Cracow, May 9, 1905.) —Meyer and v. Schweidler have found [see Abstract No. 533 (1905)] if UrX is separated from uranium nitrate by shaking the aqueous solution with ether according to Crookes' method, that its rate of decay is abnormal. It reaches half value in 2 days instead of the 22 found by Rutherford. This paper is an investigation as to the cause of this. The rate of decay is quite normal if the evaporation of the aqueous portion is carried far enough to drive off the water of crystallisation. Proceeding exactly according to the method of Meyer and v. Schweidler the decay curve is different according to which crop of crystals is taken. A discussion of the results shows that the first crystals produced from the aqueous solution contain even less than the equilibrium amount of UrX; nearly the whole of this substance is found in the mother liquor. If the activity of the liquid is tested while crystallisation is proceeding, a large increase in the β-ray activity is observed during the process, but this is not the case if the liquid is stirred in the meantime. All the observations are explained by the fact that the crystallisation starts at the bottom of the vessel and the upper portions become relatively richer in UrX. The top and bottom of the plate of crystals formed give a different initial activity and a different rate of decay. Conclusive experiments are performed in support of this view, and it is shown that UrX can diffuse through a crystal plate even in the absence of water. The author looks on the UrX, and in fact the other active products, such as ThX and thorium emanation, as existing in a state of solid solution, and he supposes that the diffusion takes place as the result of a species of osmotic pressure. The abnormal rate of decay is merely a result of the crystallisation causing a mixture of UrX and the original uranium salt in different proportions. R. S. W.

REFERENCES.

1591. *Reflection of Light by Coloured Papers.* **H. D. Minchin.** (Amer. Journ. Sci. 19. pp. 445–450, June, 1905.)—The light reflected by a series of coloured papers is analysed by means of a Brace spectro-photometer, the light sources employed being two 250-volt 16-c.p. lamps. It is elicited that less than 0·02 of the incident light is reflected by the best paper used, when all conditions are the best possible.

G. E. A.

1592. *Radiation in Dispersive and Absorptive Media.* **M. Laue.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 117–127, 1905.)—A former paper [see Abstract No. 1227 (1905)] dealt with plane waves, whereas the present article extends the same reasoning to spherical radiation. E. H. B.

1593. *Over-exposure in Röntgen Ray Photography.* **E. H. Howlett.** (Röntgen Soc., Journ. 1. p. 73; Discussion, pp. 73–74, April, 1905.)—From a consideration of two Röntgen-ray photographs reproduced, one of which was exposed 100 times longer than the other, the author comes to the conclusion that, the latitude of exposure being so great, it is practically impossible to over-expose. In the *discussion*, however, **Glew** and **Rodman** both considered over-exposure in the sense of diminished contrast, as quite possible. L. H. W.

1594. *Absorption Spectrum of Phenylmethylacridol.* **J. J. Dobbie** and **C. K. Tinkler.** (Chem. Soc., Journ. 87. pp. 269–273, March, 1905.)—The authors find confirmation of Hantzsch's view from an examination of the absorption spectra of the methiode and of the hydroxide derived from it. D. H. J.

1595. *Influence of very Strong Electromagnetic Fields upon the Spark Spectra of Gold, Antimony, Bismuth, Lead, and Tin.* **J. E. Purvis.** (Cambridge Phil. Soc., Proc. 13. pp. 82–91, May 24, 1905.)—The observations were made with a field of 40,000 c.g.s. units and a 21-ft. focus concave grating. Details are given of the results obtained. E. C. C. B.

1596. *Radio-activity of some Deep Well and Mineral Waters.* **H. Schlundt** and **R. B. Moore.** (Journ. Phys. Chem. 9. pp. 320–332, April, 1905.)—Several of the deep well waters and a mineral water at Columbia, Missouri, have been tested by the electroscopic and electrometer methods. The radio-activity observed is stated to be due to the presence of radium emanation, from the similarity of the decay curve with the curve obtained from air exposed to a "solution" of radium. The values are expressed in terms of Boltwood's standard. L. H. W.

1597. *Fluorescence of Air Produced by Radio-tellurium.* **W. Marckwald** and **K. Herrmann.** (Deutsch. Phys. Gesell., Verh. 7. 11. pp. 227–229, June 15, 1905.)—When radio-tellurium ionises air something is produced which is capable of affecting a photographic plate even though no direct radiation could fall thereon. This is found to be due to the fluorescence of the gas. R. S. W.

1598. *Radio-activity of some Fresh-water Springs.* **A. Schmidt.** (Phys. Zeitschr. 6. pp. 402–406, July 1, 1905.)—Fuller results of the investigation dealt with in Abstract No. 990 (1905). These have led the author to think that an active element (radium) is present in the salt from the Kurtz spring, and not merely an emanation. L. H. W.

HEAT.

1599. *Calculation of Heat Conductivity by a Graphical Method.* **H. Diesselhorst.** (Phys. Tech. Reichsanstalt, Wiss. Abh. 4. pp. 187–191, 1905.) —The temperature at a point in a rectangular slab of material is observed at known intervals of time, reckoned from the moment of establishing a change of temperature at one end. The conductivity can then be calculated, as in the experiments of F. A. Schulze, of E. Grüneisen, and E. Giebe [see Abstracts Nos. 808 (1899), 9 (1901), and 1199 (1903)]. $w = \mathrm{CU}(z)$, where $z = x/2\sqrt{kt}$ and $\mathrm{U}(z) = \frac{2}{\sqrt{\pi}}\int_z^\infty e^{-y^2}dy$, k being the conductivity, x the distance from the cooled end of the slab, and t the time from the commencement of cooling. From these we have—

$$\log t = \log\frac{1}{z^2} - \log\frac{4k}{x^2} \text{ .... } (1)$$

and—

$$\log u = \log \mathrm{U} + \log \mathrm{C} \text{ .... } (2).$$

If now two curves are plotted, one with log U as ordinate, and log $1/z^2$ as abscissa, and the other with log u as ordinate and log t as abscissa, the vertical displacement required to make the curves coincide is equal to the constant quantity log $4k/x^2$, from which k can be calculated. If then equation (1) is subtracted from (2), we have $\log(w/t) = \log z^2\mathrm{U} + \log(4kc/x^2)$. Tables of calculated values of $\log 1/z^2$, log U, and $\log x^2\mathrm{U}$ are given, and the curve for $\log 1/z^2$ and $\log z^2\mathrm{U}$ is constructed. The observed results of t and u are also given, along with the corresponding values of log (w/t), the curve for log t and log w/t being drawn on tracing-paper, to be laid upon the first curve. The displacement of the axis of ordinates required to produce the coincidence of the two curves is the value of $\log 4k/x^2$. The corresponding calculation and figures when the end of the slab is suddenly warmed instead of cooled are also given, and an example explaining the use of the curves is given.

S. G. S.

1600. *Thermal Expansion and Elasticity of Stone.* (Eng. News, 53. p. 631, June 15, 1905. From U.S. Geological Survey's "Stone Industry in 1903.")—Tables of compression tests are included in the original report. In this abstract the results of tests of the expansion coefficients of granite columns 20 in. long between 32° and 212° F. are given as follows :—

	Coefficient of Expansion per 1° F.		Coefficient of Expansion per 1° F.
Arkansas granite	$3{\cdot}41 \times 10^{-6}$	Massachusetts granite...........	$3{\cdot}11 \times 10^{-6}$
„ „	3·24	Maine „	3·11
California „	4·61	Maine slate	5·00

Tests on the modulus of elasticity of granite pieces 20 in. long and 4 × 6 in. cross-section, under compression, gave the following values. Maine granite, $9{\cdot}8 \times 10^6$; Arkansas granite, $6{\cdot}95 \times 10^6$, $8{\cdot}16 \times 10^6$, and (156 lbs. per cub. ft.) $6{\cdot}09 \times 10^6$. Washington sandstone (2-in. cubes) $1{\cdot}14 \times 10^6$ (average). L. H. W.

1601. *Determination of Specific Heat and Heat of Dilution of Liquids.* **T. W. Richards** and **A. B. Lamb.** (Amer. Acad., Proc. 40. No. 20. pp. 659–680, April, 1905. Contribution from the Chem. Lab. of Harvard University.)—New methods are described for determining the specific heat and heat of dilution of liquids, the first being an improvement on that of Hesehus, whereby cold water is run into the calorimeter simultaneously with the hot liquid at such a rate that the temperature in the calorimeter is kept constant. The thermometers can thus all be read while stationary, so avoiding any error from thermometric lag, while any slight error due to cooling during transference is compensated by an equal and opposite heating effect. For measuring the heat of dilution of a solution the authors use a beaker divided into equal parts by a detachable partition of silver foil, which is held in position by a narrow U-shaped ledge of glass cemented to the walls and floor of the beaker, and made water-tight by means of hard paraffin. One compartment is filled with water, the other with the solution, and the whole placed in the calorimeter. When both liquids have practically the same temperature the partition is removed, the mixed liquids stirred, and the temperature read. The method proposed by Berthelot for determining from the change of the heat of dilution with temperature the specific heats of increasingly dilute solutions, has been tested with satisfactory results; and a simple method for determining the water adhering to glass vessels, and the construction of a very sensitive thermostat are described.

W. H. Si.

1602. *Elimination of Thermometric Lag and Accidental Loss of Heat in Calorimetry.* **T. W. Richards, L. J. Henderson,** and **G. S. Forbes.** (Amer. Acad., Proc. 41. No. 1. pp. 3–19, May, 1905. Zeitschr. Phys. Chem. 52. pp. 551–568, Aug. 8, 1905.)—A modification of the divided beaker proposed by Richards and Lamb [see preceding Abstract] has been devised, which allows a better regulation of the speed of reaction. It consists of a large test-tube immersed in the calorimeter vessel, and having two holes, one in the side above the liquid level, the other in the middle of the bottom, closed until the moment of reaction by a rubber stopper upon a rod running down through the axis of the tube. The two liquids are placed in the tube and calorimeter respectively, and to start the reaction the stopper is displaced and the test-tube further immersed, so that both holes open under the liquid level, the liquid being circulated by screw-propeller vanes. It is shown that the thermometric lag behind the temperature of even a slightly cooling or warming environment causes an appreciable error in its estimation, but that this lag, though easily determined and corrected for, may be entirely obviated, as well as all other corrections for cooling in calorimetric work, by altering the temperature of the environment at the same rate and to the same degree as that of the calorimeter proper, this being effected in the authors' experiments by running sulphuric acid into a jacket containing sodium hydroxide solution. W. H. Si.

1603. *Specific Heat of Superheated Steam.* **A. H. Peake.** (Roy. Soc., Proc. Ser. A. 76. pp. 185–205, June 28, 1905. Page's Weekly, 6. pp. 1287–1290, June 16, 1905. Abstract.)—Two methods were adopted. In the first the rise in temperature produced in a known quantity of steam by supplying a definite amount of heat was measured; and from this the specific heat was calculated. The second method was to allow dry saturated steam to expand without doing external work, and observe the resulting change in temperature. It is well known that if dry saturated steam be allowed to expand in this way without loss of heat it becomes superheated. The direct object of the experiments was to determine the law connecting the temperature and pressure of superheated steam during this free expansion; then from this law and Regnault's tables of the total heat of saturated steam, the degree of superheat, and the amount of total heat corresponding to this superheat, can be obtained at any particular pressure lower than the initial pressure of the steam, and hence the mean specific heat over that range of superheat, and also the manner in which it varies—if the law be known for various initial pressures—may be calculated. The author finds, however, that Regnault's tables are not sufficiently accurate to enable the specific heat to be obtained by this method with any degree of accuracy. The values obtained from the throttling experiments show an increase in the specific heat from 0·43 at 230° C. to 1·00 at 350° C. But from the other method it is found that the variation of the specific heat with temperature must be small, and by no means of the order indicated by the results of the throttling experiments based on Regnault's tables. The mean of all results gave the value 0·48, but the author believes the value 0·46 to be more accurate, as this is the average of the values obtained in the most satisfactory experiments. A. W.

1604. *New Type of Electric Furnace, with Redetermination of the Melting-point of Platinum.* **J. A. Harker.** (Roy. Soc., Proc. Ser. A. 76. pp. 235–250, June 28, 1905.)—Describes an electric tube-furnace in which the conducting tube consists of the materials used in the Nernst lamp filaments. The construction and mode of working are described in detail, the most important point being the adoption of a "cascade" arrangement for the furnace. A spiral of nickel wire is wound upon an outer cylinder of hard porcelain and, when properly protected against oxidation and excessive radiation, is kept at a temperature of 1,000° C.; the heating tube proper can then be kept at temperatures of 2,000° C. and over by means of very small currents, thus avoiding the difficulty arising from electrodes required to carry relatively heavy currents. The vertical type of furnace was used for melting-point determinations of platinum. These determinations were made by means of thermo-junctions of platinum and platinum-iridium and platinum-rhodium; when such a junction is immersed in a furnace kept at a temperature above the melting-point of pure platinum, but below that of the alloy, the wires either spring apart as soon as the platinum wire reaches its melting-point, or a small globule of fused platinum is formed and either drops off or climbs up the alloy wire; in either case the temperature at which this happens can be readily determined to within 2 or 3°. A large number of thermo-junctions, whose properties had been accurately studied at temperatures between 400° and nearly 1,300° C., were available, and from these a number of characteristic examples were chosen, differing as widely as possible in their properties. For each couple, the temperature corresponding to the value of the e.m.f. found at the melting-point of platinum was found by extrapolation from the previously determined formula. The agreement between the values found in this way was such as to justify the conclusion that the value 1,710° C. represents to within 5° the melting-point of platinum, as found by the thermo-electric method. The validity of this result is further confirmed by a series of determinations of the melting-point of nickel carried out with some of the same junctions; equally good agreement at this point answers the objection that the agreement near 1,700° might be fortuitous. Other prospective uses of the new type of furnace are suggested, and full references to earlier literature of the subject given. W. Ros.

1605. *Difference of Temperature of Glowing Platinum and Black Body with Equal Photometric Brightness.* **R. Lucas.** (Phys. Zeitschr. 6. pp. 418–419, July 1, 1905.)—Employing the logarithmic expression: $\log \phi = -(k/T) + C$, connecting brightness ϕ and absolute temperature T [see Abstract No. 719 (1905)], the author deduces the relation $\delta_1 = a\delta_2 + \beta$ between δ_1 and δ_2 the reciprocals of the absolute temperatures of the black body and of platinum for equal brightness. The constants a and β are evaluated from experimental data by the method of least squares, and the equation then stands—

$$\delta_1 = 0{\cdot}98573\delta_2 + 0{\cdot}00005977.$$

Observed and calculated values of the "black" temperature are then compared. [See also Abstract No. 1237 (1905).] G. E. A.

1606. *Molecular Attraction.* IV. *Biot's Vapour Pressure Formula and Relations at the Critical Temperature.* **J. E. Mills.** (Journ. Phys. Chem. 9. pp. 402–417, May, 1905.)—The author shows that the $\partial P/\partial T$ for a liquid (vapour) at the critical temperature is exactly twice what it would be for the same substance as a perfect gas occupying the critical volume. Biot's formula for vapour pressure cannot be made to fit exactly the true vapour pressure curve in the immediate neighbourhood of the critical temperature. When the pressure is considered, the proportional error is very small, but when the $\partial P/\partial T$ is considered the proportional error is large, and the values obtained from Biot's formula are too small. The equation—

$$(L - E_1)/(\sqrt[3]{d} - \sqrt[3]{D}) = \mu',$$

where μ' is the constant of molecular attraction, is shown to be applicable with exactness in the immediate neighbourhood of and at the critical temperature for fifteen out of nineteen substances considered; the equation has already been shown to hold at lower temperatures. The constant of molecular attraction, μ', can be calculated from the critical constants and the molecular weight. The fact that the ratio of the theoretical critical density to the actual critical density is a constant for all substances is shown to follow necessarily from the fundamental ideas and equations brought forward by the author. [See also Abstract No. 561 (1905).] T. H. P.

1607. *Vapour Pressure by Air-bubbling.* **E. P. Perman** and **J. H. Davies.** (Roy. Soc., Proc. Ser. A. 76. pp. 174–176, May 24, 1905.)—Experiments made to investigate some possible sources of error in the determination of vapour pressure by air-bubbling show that no naturally occurring supersaturation, or dust, or electrification of the air would have any appreciable effect on the result. [See also Abstract No. 777 (1905).] **Berkeley** and **E. G. J. Hartley.** (Nature, 72. p. 222, July 6, 1905.)—Berkeley and Hartley point out that an objection to Oswald and Walker's method is the inherent inaccuracy due to the space occupied by a bubble of air, when leaving the solution, being less than that occupied by the same bubble when leaving the water, so that the bubble expands while travelling up the water column, and will take up more water-vapour than it should. In applying the method to the determination of osmotic pressures, this error is magnified, and the authors have, therefore, had to abandon it. W. H. Sr.

SOUND.

1608. *Acoustics of Halls.* **S. Exner.** (Bull. Soc. d'Encouragement, 107. pp. 571–589, May, 1905. From Zeitschr. des österreich. Ingenieur und Architekten Vereins, 1905.)—The acoustics of otherwise well-built halls are often deplorable, owing to the neglect of provision for eliminating echoes. The author indicates the general principles on which auditoriums should be designed. A low ceiling is best for carrying sound. Many lecture-halls might be advantageously reduced to half their height. Air-space per head might be replaced by artificial ventilation, and cost of building and heating reduced. Curved or arched ceilings should be avoided, as the curved surfaces act as concave mirrors and concentrate the sound in wrong places. Halls where hearing, rather than seeing, is the main object should be long and narrow, like a tunnel, or in that direction. Echoes should be reflected towards a window, a curtain, or at least a wooden partition, so as to be absorbed, and not towards a stone wall. The author describes an apparatus for testing the acoustic qualities of halls. By its means he measures the intensity of the original sound, the duration of the echo, and the intensity of the echo at a given moment. As source of sound he employs a detonator fired at the platform by an operator in a distant room by means of an electric firing circuit. The operator studies the sound at various places in the hall by means of a telephone, increasing the resistance of the telephone circuit until he ceases to hear the report. To determine the duration of the echo, a contact is inserted in the circuit and arranged so as to act a certain time after the report. The time is increased to extinction. To find the intensity of the echo matters are so arranged that the telephone circuit is only made after a certain interval, and then the sound is measured in the same manner as the original sound. E. E. F.

1609. *Autexophone for Reinforcing Gramophone Sounds.* (Scientific American, 92. p. 382, May 13, 1905.)—The autexophone, invented by C. A. Parsons and H. Short, is practically a pneumatic relay. It consists of a small valve made in the shape of a comb whose teeth cover the gaps in a corresponding comb of brass. The valve takes the place of the usual diaphragm, is made of magnalium, and controls the supply of air under pressure from a reservoir (2 lbs. per sq. in.). It is hinged on steel springs, and, being connected to the needle of the gramophone, the motion of the valve corresponds exactly to the motion imparted by the record. The arrangement is said to have the property of enforcing the harmonics, giving increased fulness of tone. An illustration of the complete gramophone is given, but no details. L. H. W.

1610. *Acoustic Apparatus.* **W. Stern.** (Phys. Zeitschr. 5. pp. 693–696; Discussion p. 696, Oct. 20, 1904. Paper read before the 76 Naturforscherversamml. at Breslau, Sept. 21, 1904.)—An instrument consisting essentially of a cylindrical resonator with movable piston is described. The resonator is excited by an applied jet of air under pressure. By moving the piston a continuous variation of pitch can be obtained and can be read on an indicator. The tones have constant intensity. J. W. P.

REFERENCE.

1611. *Flame Tube for Acoustic Observations.* **H. Rubens** and **O. Krigar-Menzel.** (Ann. d. Physik, 17. 1. pp. 149–164, June 9, 1905.)—A fuller account of the experiments dealt with in Abstracts Nos. 570 and 571 (1905). E. E. F.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1612. *Electrons exceeding the Speed of Light.* **E. Wiechert.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 75–82, 1905.)—The electrodynamic theory shows that, at speeds exceeding that of light, an electrified body experiences a retarding mechanical force of electrodynamical origin, though the motion is straight and uniform. Sommerfeld has shown that this retarding force for a spherical electron with uniform distribution of the charge is expressed by—

$$F = (9E^2/4a^2)(1 - c^2/v^2) \qquad (1)$$

in which F is the mechanical force, E the electrostatic measure of the charge, a the radius, c the speed of light, and v that of the electron. The present paper deals with changes of the speed v of the electron, to which, however, is fixed an inferior limit v_0, which is itself greater than the speed of light. Thus in the cases considered we always have—

$$v > v_0 > c \qquad (2).$$

Various forms of body and types of distribution of charge are treated, and the following conclusions derived respecting them. The retarding mechanical force of electromagnetic origin is completely independent both of the velocity and of its change provided the inequality (2) is fulfilled. Thus we have here a case in which it appears impossible to speak of an "inertia" due to the electric charge. A constant resistance is present and nothing more. [See also Abstract No. 2254 (1904).] E. H. B.

1613. *Report on International Electrical Congress. Units and Standards.* **W. Duddell.** (Inst. Elect. Engin., Journ. 34. pp. 171–176, Feb.; Discussion, 35. pp. 3–42, June, 1905.)—[The *discussion* also relates to the papers on Units and Standards, Abstracts Nos. 173, 792, and 1026 (1905).] The following questions were put, and members invited to express their opinion thereon: (1) What is the true value of the volt and ampere? (2) Is it better to adopt a standard to represent the volt or to represent the ampere? (3) If a standard for the volt is adopted it will probably be in the form of a cell. Is the Clark or the Weston cell the more suitable? (4) If the ampere be adopted is the silver voltameter the most satisfactory form for this standard, or should some form of current balance be employed? (5) Should the legally defined fundamental units be the c.g.s. units or those obtained by assigning values to the concrete standards? With regard to the magnetic units, (6) Shall the 4π be removed? If not, (7) shall the c.g.s. magnetic units or those consistent with the volt-ampere-ohm system be given names? (8) Do the c.g.s. electric units need names? If so, (9) how shall the names be formed? (10) In the event of the formation of a permanent International Commission can the Institution of Electrical Engineers help the work of the Commission? **Rayleigh** thinks too much is taken for granted about the ohm, and as the accuracy of the ohm has an important bearing on the choice of the secondary principal standard, the ampere is preferable from the theoretical standpoint. The Weston cell he believes to be preferable to the Clark, but owing to the short experience we have had of it he advises caution. **W. E. Ayrton** discusses the accuracy with which the ohm is known in absolute measure, and points out the considerable uncertainty of the fifth figure. He also deals with Carhart's determinations of the e.m.f. of the Clark cell, and indicates that the only result so far gained from the experiments is the knowledge that the assigned value of the e.m.f. is too high. As in the near future a Lorenz apparatus is to be constructed at the National Physical Laboratory he thinks that, for the present, we should put aside the question of the ohm in specifying the value of the amp. A brief description with illustrations of the new amp. balance constructed at the National Physical Laboratory is also given. **A. P. Trotter** deals with the distinction between the *unit* of e.m.f. and the *standard* of e.m.f. **F. E. Smith** refers to the degree of reproduction of standards and their constancy. The mercury ohm he believes to be a reproducible concrete unit to 2 or 3 parts in 100,000, but very small changes may result. With regard to the standard cell he is practically in agreement with Carhart. The figure of reproduction and constancy he places at about $\frac{1}{100000}$ of a volt. **R. T. Glazebrook** expresses his agreement with Trotter's remarks, and also points out that the uncertainty of the e.m.f. of the Clark cell and the difference between the Reichsanstalt and British values is of commercial importance, as it suffices to make differences in the sale and purchase of lamps. **S. P. Thompson** is of opinion that if we are bound by any one of our three electrical standards we have no need whatever to define as standards (except in a secondary sense) the other two. Seeing that the watt is defined by being absolutely deduced from the standards of length, mass, and time, whichever one electrical unit we choose we thereby settle the other two. Turning to the other question of magnetic units, he thinks that a great advance has been made by the proposal of Giorgi. **R. E. B. Crompton** has been working for many years to perfect tertiary standards, and disagrees with Duddell's statement that an accuracy of one half of 1 per cent. is sufficient for these. **H. E. Harrison** is not in agreement with Thompson about the 4π; he thinks that we should for ever be trying to make our standards more and more accurate. **J. Perry** points out with regard to the Giorgi system that the 4π is not abolished, it is simply shunted elsewhere; that is, the permeability of air, instead of being 1 is $4\pi 10^{-7}$ or $4\pi 10^{-9}$ or some other inconvenient number. He strongly advocates the adoption of the Heaviside system. The paper is not suitable for a brief abstract, and should be referred to. F. E. S.

DISCHARGE AND OSCILLATIONS.

1614. *Increase of Pressure at the Anode as a Consequence of the Discharge.* **J. Stark.** (Boltzmann Festschrift, pp. 399–409, 1904.)—From a consideration of the transport of positive and negative ions of an elementary gas, it would appear that if a vacuum tube be divided between the electrodes (by means of a capillary tube) into an anodic half and a kathodic half, the gas pressure should be increased in the kathodic part; at a pressure of 0·01 mm. of mercury and with 1/10 milliamp. the increase should be about 1·7 per cent. In the experiments a wide tube was placed near one electrode and the change of current noted according as this electrode was made anode or kathode. An increase of pressure is actually found to occur. L. H. W.

1615. *Recombination and Diffusion of Ions.* **Langevin.** (Journ. de Physique, 4. pp. 322–333, May, 1905.)—A mathematical paper. McClung's independence between the pressure of the gas and the coefficient of recombination of the ions is certainly incorrect by reason of an influence of diffusion of the ions, which may assume preponderance of effect at feeble pressures or at high temperatures. Approximate corrections made on this account in McClung's results bring these very near to the author's own observations, which bring out, at pressures below the atmospheric, coefficients of recombination proportional to the pressure. The rapid increase of recombination with rise of temperature estimated by McClung is also affected by the same cause of error. It is experimentally possible to reduce the disturbing effect of diffusion by never allowing a permanent *régime* to be set up and by taking advantage of the fact that as a rule the variable state of diffusion continues for a much longer time than that of recombination. A. D.

1616. *Method of increasing Spark-length of Wimshurst Machine.* **B. J. Palmer.** (Cambridge Phil. Soc., Proc. 13. pp. 60–68, May 24, 1905.)—When a machine is giving its maximum spark for a given rate of rotation, holding a finger or an earthed conductor near the negative pole doubles the spark-length. A similar effect is obtained with greater difficulty at the positive pole. Holding an insulator near the positive knob also causes a great increase in the spark-length. The effects are still greater if the positive discharge knob is the smaller of the two. No reason for this behaviour has yet been ascertained. R. S. W.

1617. *Positive Leak from Hot Platinum.* **O. W. Richardson.** (Cambridge Phil. Soc., Proc. 13. pp. 58–59, May 24, 1905.)—The author has already shown that the positive leak from a hot platinum wire falls off asymptotically with the time. If fresh air be admitted from time to time, and the wire reheated, this falling off reaches a limit. The present experiments have been made to see if the magnitude of the current in this state is affected by the surrounding gas. Air is admitted to a pressure of 2 cm. and then pumped out. The leak is found to fall off at constant temperature in a similar way to that from a new wire; when the decay is small readings are taken at different pressures. The leak consists of two parts, one of which is proportional to, the other independent of, the pressure. The latter part is nearly independent of the voltage between 40–200 volts. R. S. W.

1618. *Effect of Radiations on the Point Discharge.* **E. Warburg** [with **F. R. Gorton**]. (Deutsch. Phys. Gesell., Verh. 7. 10. pp. 217–224, May 30, 1905.)—Ultra-violet and radium radiations are found to have no influence on the minimum potential required to maintain the discharge provided the point is freshly prepared. If the point is heated in a flame, or is used for some time to produce a discharge, this potential is raised considerably; exposure to the radiations while the current is passing at once brings it to its original value. This effect is temporary; removal of the radium, for example, is followed immediately by a rise in the potential. Warburg has found previously that the minimum potential is less at $-186°$ than at 18°. Exposure to the radiations does away with this difference, and also causes the sparking and minimum potentials to take equal values. The voltages in the halogens are considerably higher than in air or in H, O, N. [See also Abstract No. 607 (1905).] R. S. W.

1619. *Effect of Magnetic Field on Vacuum-tube Discharge.* **J. Peck.** (Phil. Mag. 10. pp. 67–70, July, 1905.)—The effect of a transverse field on the resistance when the kathode is heated and coated with calcium oxide is investigated. The decrease in resistance at the kathode is found to depend on the existence of a large kathode fall of potential. If the kathode fall is small the field produces increase of resistance at the kathode just as in other regions of the tube. [See also Abstract No. 1037 (1905).] J. W. P.

1620. *Production of Continuous Electrical Oscillations.* **V. Poulsen.** (Internat. Elect. Congress, Trans. 2. pp. 963–971, 1905.)—The author describes a method of producing electrical oscillations, evolved from his experiments on the singing arc, which is characterised by the increased intensity obtainable. In the experiments it was noticed that the note emitted by the singing arc between horizontal carbons was abated in pitch when the ends of the carbons were held over the flame of a spirit lamp, the alternating current increasing and the direct current diminishing. The note also increased in pitch when the direct current was increased. The same effect was produced by hydrogen, coal-gas, ether, and ammonia-gas, and even by water vapour at low frequencies; the effect is therefore probably due to the hydrogen, *i.e.*, the reduction of oxidation. The superiority of the hydrogen arc is most pronounced when the ratio (inductance)/(capacity) in the condenser circuit is made large. The frequency obtained varied from several hundred thousand to several millions (with less intensity) per sec. When the oscillatory arc was placed in a magnetic field the p.d. between the condenser plates was found to be greatly increased, and so this arrangement was adopted. On separating the electrodes the direct current decreases until the oscillations begin; the direct current then increases, showing that the oscillations lower the resistance of the arc. The length of arc is different in spirit vapour to that in air, for maximum current in condenser. With the arc in the magnetic field the above ratio L/C can be greater than otherwise; when L/C is small the field is useless. As electrodes carbon-carbon or copper (cooled) as + to — carbon are best. To make the apparatus work regularly the electrodes must be scraped (by rotating them). The efficiency obtained with 3,170 watts (at 440 volts) direct current and frequency 5×10^4 was about 50 per cent.; with 2,800 watts and frequency $1{\cdot}6 \times 10^5$, about 29 per cent. Thus a comparatively large amount of energy can be obtained in the high-frequency circuit. The various experimental effects obtainable are then described, and an arrangement with two oscillatory circuits of the same frequency shown by which twice the voltage is obtained. The utility of the method for wireless telegraphic and other purposes is pointed out.

L. H. W.

1621. *Apparatus for Demonstrating Stationary Electrical Oscillations.* **E. Grimsehl.** (Phys. Zeitschr. 6. p. 379, June 15, 1905.)—A modification of the Arons tube is described. A long horizontal tube exhausted to low vacuum has two tin-foil strips running its entire length, one on the upper surface and one on the lower. The strips are joined at one end to the oscillator, and the points of the tube where the strips differ greatly in potential are made evident on account of the discharge across the tube, while at the nodes no discharge takes place. The metallic bridge consists of a spring clip bearing on the two strips, and it can thus be easily moved. S. G. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1622. *Mercury Standards of Resistance.* **W. Jaeger** and **H. Diesselhorst.** (Phys. Tech. Reichsanstalt, Wiss. Abh. 4. pp. 195–205, 1905.)—This paper contains an account of a comparison in January, 1904, of three 1-ohm mercury standards of the Reichsanstalt with various manganin standards of resistance. The Kohlrausch method in which a differential galvanometer is employed was again used, it being pointed out that the Thomson double-bridge has disadvantages for this particular kind of work owing to the connecting resistances of the mercury standards being about $\frac{1}{10}$ of the value of the standard employed, whereas when wire resistances are compared these connecting resistances can be made very small. The Kohlrausch method is also shown to be more sensitive than the double-bridge provided that the most favourable galvanometer resistance be in each case selected. Before and after the comparison with the mercury standards four special manganin standards were intercompared, the comparison being made with all six combinations in order to ascertain the degree of accuracy of the measurements. Differences of about 1 part in 1,000,000 are recorded. The filling of the tubes *in vacuo* was made in the usual manner, and for the resistance measurements they were immersed in petroleum, the temperature of which was slightly higher than 0° C. Each tube was twice filled and its resistance determined, the difference in the resistances resulting from the first and second fillings being 13, 10, and 44 parts in a million. The mean value M of the four manganin resistances employed has varied but slightly since 1897, as the following table shows :—

	June, 1897.	March, 1903.	February, 1904.	Mean.
M calculated from XI.	1·001730$_5$	1729	1703	1721
„ „ XIV.	1762	1759	1764	1762
„ „ 114	1725$_5$	1743	1726$_5$	1732

The numbers XI., XIV., and 114 refer to the three mercury standards. Since the comparison of the manganin standards with each other can be made with approximately ten times greater accuracy than the determination of the legal values of the mercury standards, one is justified in looking upon the variation in the above table as being due to errors of observation. F. E. S.

1623. *Electric Resistance of Steel.* **P. Mahler.** (Soc. d'Encouragement, 107. Rev. de Métallurgie, pp. 345–347, May, 1905.)—The resistances of a series of steels of varying hardness were observed, and are compared with those given by the formula, $R = 10 + 7C + 5Mn$. C and M*n* represent the percentages of the elements in the steel, the coefficients 7 and 5 are from le Chatelier's results, and the formula gives sufficiently close approximations for use in practice. It fails to apply, however, to metal taken at several stages in the course of manufacture by the Siemens-Martin process, giving always too high a value of the resistance, except for the final metal. Thus it appears that steel of low resistance can be more readily produced than mechanically-good steel. Probably the occluded gases play an important part in modifying the resistance. F. R.

1624. *Measurement of Small Coefficients of Self-induction.* **M. La Rosa.** (Accad. Lincei, Atti, 14. pp. 621–627, June 8, 1905.)—Four resistances are arranged as in the Wheatstone's bridge, one arm containing the inductance to be measured. The arm opposite to this must have high resistance, but the three others small resistance, for greatest sensitiveness. If r_4 is the resistance of the arm having inductance L, and r_2 that of the high resistance, the latter is shunted by a condenser of variable capacity C. The resistances are adjusted for equilibrium with steady current, and C is then varied until equilibrium with variable current is attained. Then $L = Cr_2r_4 = Cr_1r_3$. With this arrangement the author has measured inductances of about 1,000 cm. to within an error of 3 per cent. S. G. S.

1625. *Relation between Dielectric Constant and Density of Air.* **A. Occhialini.** (Accad. Lincei, Atti, 14. pp. 613–620, June 3, 1905.)—Two condensers are in parallel, one being adjustable and of known capacity, the other being of fixed dimensions and having air under pressure varying in the different experiments as dielectric. A rapidly alternating current (10,000 ∿) is employed, and the adjustable condenser varied until the fall of potential across the two condensers is the same. The condensers are of special form, their construction and the method of maintaining the air pressure being described. The values of K, the dielectric constant, together with $(1/D)(K-1)/(K+2)$ and n^2 are tabulated. (D is the density and n the index of refraction of the air.) It is found that the former expression, due to Mossotti, decreases slowly as the pressure rises. Assuming a mean value for it, the dielectric constant of liquid air is found to be 1·475; Dewar has found it to be 1·495. The value of n^2 rises with increasing pressure. [See also Abstract No. 1111 (1901).] S. G. S.

1626. *Thermoelectric Power and Thomson Effect.* **Ponsot.** (Comptes Rendus, 140. pp. 1585–1587, June 13, 1905.)—Continuing from a previous result [see Abstract No. 568 (1903)], the author arrives at the following conclusion: If a chain of metals, at a temperature lower than the lowest neutral point of a couple formed by any two consecutive metals, be so arranged that a current absorbs heat on passing from one metal to the next on the right, the classification according to decreasing coefficient of Thomson effect is also that in which the thermoelectric power of one metal to the following is positive. G. E. A.

1627. *Dielectric Constants of Metals.* **A. Broca.** (Comptes Rendus, 140. pp. 1677–1680, June 26, 1905.)—In researches by Turchini and the present author on the resistance of wires to high-frequency currents it was shown [see Abstract No. 1276 (1905)] that the results were not in accord with the calculations of Kelvin as to the ratio of resistances to steady and alternating currents. The present note shows that the introduction into the calculation of the dielectric constant is competent to bring it into accord with experiment. On this hypothesis copper is shown to have for frequencies near 1,000,000 a dielectric constant of the order 10^{11}. [Erratum, Ibid. 141. p. 80, July 3.] E. H. B.

1628. *Vacuum Thermo-element for Hertz-wave Experiments.* **C. Schaefer.** (Zeitschr. Instrumentenk. 25. pp. 133–135, May, 1905. Inst. d. Univ., Breslau, March 28, 1905.)—A thermo-couple of iron and constantan is contained in a glass tube 25 cm. long, the connections passing from each end to the thermo-couple in the middle. The elements of the couple, after being twisted together, are bent at right angles to the length of the tube and connected to two brass resonators which project through the sides of the tube. The resonators are 3 cm. long, and therefore adapted for waves of a minimum length of 6 cm.; they may also be used as sockets to carry longer resonators. The paper explains how the device is put together. The sensitiveness of the thermo-element is increased five to ten times in a vacuum of 0·01 mm. of mercury. G. E. A.

1629. *Transmission of Rotary Motion.* (Zeitschr. Instrumentenk., Beib. 11. p. 111, June 1, 1905.)—The invention of M. Fuss consists of three conductors sensitive to radiation, arranged so as to form three equidistant diameters of a circle, the conductors not being connected at the centre, but having their middle points in connection with a suitable 3-phase rotary-field receiver. The conductors are connected in parallel across the terminals of a battery. In front of the conductors is a circular screen with a slit, by means of which any one of the six half-conductors may be exposed to the action of radiation. Instead of bolometric conductors light- or heat-sensitive cells may be employed. A. H.

1630. *Apparatus for Measurement of Magnetic Field Strength.* **F. Paschen.** (Phys. Zeitschr. 6. pp. 371–376, June 15, 1905. Écl. Électr. 44. pp. 117–119, July 22, 1905.)—Two small coils or inductors are in series. One is situated in the field to be measured, and the other in a coil of known dimensions having a current flowing in it. This current can be varied until the deflection due to the two inductors, when caused to rotate, vanishes. Their individual effects are then equal and opposite, and the unknown field is therefore equal to the field in the coil. The calibration and use of the apparatus is then described. S. G. S.

1631. *Apparatus for Observing and Recording Thunderstorms.* **A. Turpain.** (Soc. Franç. Phys., Séances, 1. pp. 33–35, 1905. Journ. de Physique, 4. pp. 512–513, July, 1905.)—Seven coherers are employed. One, the most sensitive, is connected to the antenna and is in a closed circuit with a Claude relay; the other six, of graduated sensitiveness, are on open circuit; their relative sensitiveness remains the same [see Abstract No. 2011 (1904).] When an atmospheric discharge affects the apparatus, the actuated coherer releases a rotating contact-maker, which makes one revolution and then stops. During the revolution the antenna is disconnected from the coherers and (1) the six coherers are successively introduced into a galvanometer circuit, and the deflections obtained recorded on a moving photographic plate; (2) the coherers are decohered; (3) a control current is passed through the galvanometer in the opposite direction, to make certain that decoherence has taken place and that the apparatus is again in a receptive condition. A diagram is given of the circuits. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1632. *Measurement of Small Alternating Currents.* **F. Bedell.** (Elect. World and Engineer, 45. pp. 1077–1078, June 10, 1905.)—Four incandescent lamps are arranged like the arms of a balanced Wheatstone bridge. The alternating current to be measured is sent through the bridge, and the resistance between the points to which normally the galvanometer would be connected is measured in the ordinary way by using continuous current, this measurement being clearly not interfered with by the alternating current. The value of the resistance will, however, depend on the value of the alternating current, since the lamp resistance will vary with the temperature to which the filaments are raised by the alternating current. Thus corresponding to each current there will be a definite value of the resistance, and once the arrangement has been calibrated (by means of continuous currents) it may be employed as an alternating-current milliammeter. In order to prevent any heating due to the testing current, this current is applied only momentarily, the testing galvanometer being steadily in circuit (this is permissible, as the resistances are non-inductive). A. H.

1633. *Demonstrations with High-frequency Alternating Currents.* **H. T. Simon** and **M. Reich.** (Phys. Zeitschr. 6. pp. 869–875, June 15, 1905. Phys. Inst. der Univ. Göttingen, May, 1905.)—Using the high-frequency alternator designed by Wien [see Abstract No. 877 (1904)] the authors have arranged several experiments to demonstrate inductance effects. In the first, a closed ring, which is repelled in the ordinary way by an electromagnet, is held in place, and the induced currents cause the ring to become white-hot, and eventually to melt. In another experiment two similar glow-lamps are placed respectively in parallel across two parts of a circuit in which the alternating current is flowing, one part having inductance and the other capacity. The impedance of the former decreases as the frequency decreases, while that of the latter increases. Hence at the highest frequency the lamp across the part having inductance glows the more brightly, and at lower frequencies the lamp across that part having capacity is the brighter. When the lamps are equally bright the two impedances are the same, and—

$$\sqrt{r^2 + w^2L^2} = \sqrt{r^2 + C^2/w^2}.$$

Knowing w, L and C may be compared. In other experiments resonance effects are exhibited, in which lamps glow brightly or discharges are produced when the containing circuit has a time constant in accordance with the frequency. S. G. S.

1634. *Magnetisation by Sound-production.* **St. Meyer.** (Boltzmann Festschrift, p. 68, 1904.)—A magnetic field in the direction of the axis of an iron rod produces a residual magnetism in the rod when the latter is made to emit a note. The amount of such remanent magnetisation appears to be proportional to the vibration and to the field; the poles, however, appear at the points of greatest vibration amplitude, and not where they should from a consideration of the geometrical form of the rod. L. H. W.

1635. *Ionisation and Coefficient of Magnetisation of Aqueous Solutions.* **G. Meslin.** (Comptes Rendus, 140. pp. 1329–1331, May 15, 1905.)—An examination of the specific susceptibilities of aqueous solutions of copper sulphate and potassium ferricyanide shows that the magnetic power of a solution cannot always be calculated as the algebraic sum of the magnetic powers of the solvent and solute. Thus the coefficient of magnetisation of the dissolved salt, calculated as the difference between the coefficients of solution and solvent respectively, gradually diminishes with dilution of the solution, tending towards a limit which is consistent with a gradual decomposition of the salt molecule into less magnetic elements, this ionisation being complete when a certain dilution is reached. The divergence from the calculated value is only manifested by salts which are strongly magnetic, no difference being noticed with diamagnetic or feebly paramagnetic bodies. The author further finds that with aqueous solutions of ethyl alcohol the coefficient of magnetisation is not always intermediate between those of the pure alcohol and water, the coefficient increasing on dilution with water from 1·030 (the value for absolute alcohol) to a maximum of 1·045 for a solution containing 4 per cent. water, then returning to its initial value for one with 8 per cent. water. W. H. Sr.

1636. *Hall Effect of Bismuth at High Temperatures.* **H. F. Rausch v. Traubenberg.** (Ann. d. Physik, 17. 1. pp. 78–103, June 9, 1905. Extract from the Würzburger Dissertation.)—This is an elaborate paper illustrated by figures and curves. The results may be briefly described as follows: 1. The Hall effect in bismuth was investigated in three specimen plates between the temperature of the room and the melting-point. 2. All the three plates showed a negative temperature coefficient of the rotations constant. 3. In two of the plates the rotations constant decreased with rising temperature at first quickly to about 150°, then decreased more slowly; then from about 260° decreased quicker again, and, finally, at the melting-point 270°, sank rapidly. E. H. B.

1637. *Magnetic Properties of some Alloys not containing Iron.* **J. A. Fleming and R. A. Hadfield.** (Roy. Soc., Proc. Ser, A. 76. pp. 271–283, July 10, 1905. Electrician, 55. pp. 329–332, June 16, 1905. Elect. Rev., N.Y. 47. pp. 158–161, July 29, 1905. Écl. Électr. 44. pp. 187–192, Aug. 5, 1905.)—Describes experiments by the ballistic method made on two rings of alloys composed of Mn 22·42, Cu 60·49, Al 11·65 per cent. and Mn 18, Cu 68, Al 10, Pb 4 per cent. The results of the experiments, which are given in tables and curves, show that they exhibit properties which are identical with those of a feebly ferro-magnetic material. The B-H curve is of the same general form as that of a ferro-magnetic metal such as cast iron, and indicates that with a sufficient magnetising force a state of saturation would most probably be attained. The alloys exhibit magnetic hysteresis, and it requires work to reverse the magnetisation and to carry it through a magnetic cycle; and the hysteresis is far greater than pure iron, nickel, or cobalt show for corresponding cycles of magnetisation. The first alloy has a maximum permeability of from 28 to 30, the second 14; the permeability of the first alloy is not greatly inferior to that of cobalt or a low-grade cast iron, and occupies a position intermediate between the permeability of the ferro-magnetic and the merely paramagnetic bodies such as liquid oxygen and ferric chloride. The material exhibits the phenomenon of magnetic retentivity and coercivity, and can be permanently magnetised. These results lead to the conclusion that the magnetic properties of these alloys must be based on a certain similarity of molecular structure with the familiar ferro-magnetic metals. The hypothesis which best fits the facts of ferro-magnetism is that materials such as iron, nickel, and cobalt are composed of molecular groups which are permanently magnetic, and that the process of producing or changing the evident magnetism of a mass of these metals consists in arranging or disturbing the positions of these molecular magnets. Since, then, we have in these alloys an instance of fairly strong ferro-magnetism produced by a mixture of metals, none of which possess separately any such property, it follows that ferro-magnetism *per se* is not a property of the chemical atom but of certain molecular groupings. It may consequently be possible to construct alloys which are as magnetic or even more magnetic than iron itself. [See also Abstract No. 1050 (1905).] E. C. R.

1638. *Terrestrial Magnetism.* **A. Pflüger.** (Phys. Zeitschr. 6. pp. 415–416, July 1, 1905. Phys. Inst. der Univ., Bonn.)—An attempt to explain the earth's magnetism on the hypothesis of its carrying a surface charge and being regarded as like a rotating electron. Bucherer's equation for the tangential magnetic field of such an electron [Abstract No. 1261 (1905)] is—

$$H = -\frac{R^2 e w \sin \beta}{12 \pi v r^3}$$

in which R is the radius of the sphere, r the radius vector, β the angle which r makes with the axis of rotation, w the angular velocity, v the speed of light, and e the total surface charge in electrostatic units. Putting at the equator $H = 0{\cdot}3$, $\sin \beta = 1$, $R = r = 6{\cdot}4 \times 10^8$ cm., $w = 7{\cdot}3 \times 10^{-5}$ per sec., $v = 3 \times 10^{10}$ cm. per sec., the author finds $e =$ about -3×10^{24} electrostatic units. This is on the assumption that the magnetic permeability of the earth is unity. If the interior has much iron so that μ lies between 100 and 1,000, we should have in consequence $e =$ between about -3×10^{21} and -3×10^{20}. Exner, from the potential gradient of the atmosphere, reckoned the total charge to be of the order -2×10^{16} electrostatic units, which only as regards the sign and not as regards size agrees with the above results. If Exner's result is about right, the earth's magnetism cannot be due simply to its charge and rotation. E. H. B.

REFERENCES.

1639. *Discharge Potential in Vacuum Tubes.* **O. Berg.** (Boltzmann Festschrift, pp. 793–798, 1904.)—Of three parallel electrodes in a vacuum tube, the central one was alternately earthed and then disconnected from earth, and the change produced in the p.d. between the outer electrodes observed. The earthed wire was found to have a current flowing in it, whose direction changed when the pole of the Töpler influence machine was reversed. L. H. W.

1640. *Absorption of Electric Waves.* **O. v. Baeyer.** (Ann. d. Physik, 17. 1. pp. 30–63, June 9, 1905. Extract from the Leipzig Dissertation.)—The author has measured the absorption by two methods: (1) That employed by Berg [see Abstract No. 167 (1905)]; (2) one similar in principle to that used by Wildermuth [see Abstract No. 1874 (1902)]. He finds that the former method is not very trustworthy, especially when anomalous absorption occurs. R. S. W.

1641. *The Volta Effect.* **H. Greinacher.** (Ann. d. Physik, 16. 4. pp. 708–734, April 11, 1905. Extract from the Berlin Dissertation.)—The p.d.'s between two different metal plates, separated by air rendered conducting by the action of a radioactive substance (radiotellurium), were measured on an electrometer, and comparisons made with the p.d.'s between plates separated by electrolytic liquids. The causes of the Volta effect are discussed. J. J. S.

1642. *Present Shrinkage of the Earth's Magnetism.* **L. A. Bauer.** (Phys. Rev. 20. pp. 126–127, Feb., 1905. Abstract of paper read before the Amer. Physical Soc., Dec. 30, 1904. Elect. Engin. 35. p. 293, March 3, 1905.)

1643. *Reliable Platinum Contact.* **M. Gildemeister** and **O. Weiss.** (Ann. d. Physik, 17. 1. pp. 174–179, June 9, 1905. Physiolog. Inst., Königsberg, April 9, 1905.)—A contact-maker, actuated by a pendulum previously described, is tested as regards the reliability of the contact, the time between make and break being measured electrically [see Abstract No. 11 (1901)]. The time-interval varied from 0 to 1/3000 sec., and the average error amounted to ± 0·00000129 sec. G. E. A.

1644. *Piezoelectric Constants of Crystalline Tartaric Acid.* **T. Tamaru.** (Phys. Zeitschr. 6. pp. 379–389, June 15, 1905. Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 128–158, 1905.)—The theory of the method is given and also an account of the method of applying the stress to the sides of the crystal and the determination of the dielectric constant. The method of observing and reducing the observations of deflection has been given in a previous paper [see Abstract No. 1542 (1905)]. The results are exhibited in the form of curves. S. G. S.

1645. *Influence of Concentration on the Magnetic Properties of Cobalt Solutions.* **P. Vaillant.** (Comptes Rendus, 140. pp. 1632–1634, June 19, 1905.)—From determinations of the magnetic properties of solutions of cobalt chloride, nitrate, and sulphate at various dilutions, using Becquerel's method of torsion, the author finds that the coefficient of magnetisation varies with the concentration and nature of the acid radical, but that, contrary to Meslin's results for copper salts [see Abstract No. 1635 (1905)], it diminishes with increased concentration, the variation being probably due, in the case of the nitrate, to ionisation. W. H. Si.

1646. *On the Nature of Permanent Magnets.* **R. Gans** and **R. H. Weber.** (Ann. d. Physik, 16. 1. pp. 172–177, Jan. 26, 1905.)—The well-known expression $R_m = \int_l \frac{ds}{\mu \cdot q}$, which connects the magnetic resistance with permeability, length, and cross-section of the circuit, is developed; and the relation is shown of these factors to the corresponding ones in the case of the electric circuit. But, as shown by the author, there is a want of parallelism in some respects between the conceptions in the two cases. [See also Abstract No. 827 (1905).] P. E. S.

1647. *Magnetic Properties of Salts.* **G. Meslin.** (Comptes Rendus, 140. pp. 782–784, March 20, 1905.)—Employing the method used for organic liquids [see Abstract No. 2019 (1904)], the author has determined the magnetic properties of a number of para- and dia-magnetic salts which have already been shown to present magnetic dichroism in contact with certain liquids. W. H. Si.

1648. *Magnetic Properties of Alloys of Iron and Silicon.* **T. Baker.** (Inst. Elect. Engin., Journ. 34. pp. 498–507, April, 1905.)—The magnetic properties of the alloys dealt with in Abstract No. 2209B (1904) are described more fully with curves, &c. F. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1649. *A Dynamical Theory of Diffusion for Non-Electrolytes, and the Molecular Mass of Albumen.* **W. Sutherland.** (Phil. Mag. 9. pp. 781–785, June, 1905.)—By equating the driving-force due to the osmotic gradient to the resistance to motion in a viscous medium as given by Stokes's formula, the author arrives at a formula which does not agree with experimental facts. The formula is then modified by the introduction of an empirical term, and after this emendation it gives, according to the author, a relation between molecular radius and coefficient of diffusion, which holds for substances ranging in molecular mass from hydrogen (2) to raffinose (500). The formula is—

$$B^{\frac{1}{3}}.D = b + k/B^{\frac{2}{3}},$$

where B = volume of molecules in 1 gm.-mol. of solute, D = coefficient of diffusion, and *b* and *k* are constants. Applying this formula to the Graham-Stefan coefficient of diffusion of egg-albumen, the author arrives at the value B = 27,000, and the number 32814 for the relative molecular mass compared to hydrogen. F. G. D.

1650. *Purification of Water by Continuous Fractional Distillation.* **W. R. Bousfield.** (Chem. Soc., Journ. 87. pp. 740–747, May, 1905.)—For testing how far the purification of water can be carried on by re-distillation, the author uses an exhausted receiver containing two platinum tubes which are suspended over platinum cups and cooled internally by the circulation of water. The condensed water runs from the tubes into the cups, and its conductivity can be measured between tube and cup as electrodes. As the water overflows the cups it is subjected to continuous re-distillation. The results obtained show that the cooler of the two tubes—the temperatures of which are about 18° and 20°—always condenses the purer water, as measured by its conductivity. A still devised on the principle of the above apparatus gives, from its coolest condenser tube, water of about 1 reciprocal megohm (or gemmho) conductivity, which is purer than that obtained by Stas' method of distilling successively with strong and dilute alkaline permanganate and potassium hydrogen sulphate. By storing this water in a large bottle in water freed from carbon dioxide by means of lime, its conductivity can be reduced to 0·75, and a further improvement can be effected by boiling for a few minutes in a platinum vessel. The use of glass condensing tubes in place of those of platinum gives equally good results. T. H. P.

1651. *Decomposition of Positive Colloids by the β-rays of Radium.* **V. Henri** and **A. Mayer.** (Soc. de Biologie, Comptes Rendus, 57. pp. 33–34, 1904.)—Two cub. cm. of the following colloidal solutions were exposed to the action of the β-rays from 80 mgm. of pure radium bromide for 5 days: Ferric hydroxide, Magdala red, methyl violet, colloidal silver, copper ferrocyanide, and aniline blue. As a result the three first solutions, which are positive, were decomposed; the other three (negative) were unaltered. This is considered to be due to the negative charges of the β-rays discharging the positive colloids, whose charge can no longer be replaced by flocculation due to capillary action. The aniline colours were also ultra-microscopically examined; they exhibit true colloidal properties. L. H. W.

1652. *Influence of Radium Rays upon Chlorine Detonating Gas.* **W. P. Jorissen** and **W. E. Ringer.** (Ber. Deut. Chem. Gesell. 38. pp. 899–901, March 11, 1905. Chem. News, 91. pp. 225–226, May 19, 1905.)—The authors have subjected chlorine detonating gas to the action of a tube containing 5 mgm. of radium bromide either uncovered or covered with black varnish to prevent phosphorescent light; in some cases equilibrium was only very slowly established with no apparent cause, while in others the gas was very little sensitive to light. It is intended to experiment with a larger quantity of radium salt, and to examine the influence of the radium rays on the period of induction, illuminating with a constant flame. [See also Abstract No. 217 (1905).] W. H. Si.

1653. *Chemical Separation of the Radio-active Components of Thorium.* **R. B. Moore** and **H. Schlundt.** (Chem. News, 91. p. 259, June 9, 1905.)—Rutherford and Soddy found that ThX could be separated from Th by excess of ammonium hydroxide. The authors find that the following reagents remove ThX from solutions of thorium nitrate: Pyridine, fumaric acid, aniline, potassium xanthogenate, hydrogen peroxide, ammonium fumarate, benzoic acid, and phenyl hydrazine. The Th is precipitated, and the ThX is found in the filtrate. In some cases it is found that that component of the imparted activity which falls to half value in 11 hours [ThA of Miss Slater, see Abstract No. 1396 (1905)] is soluble in excess of the reagent employed, while the ThB is precipitated with the thorium. Hence, by a combination of two methods, the ThA and ThB can be obtained separately by purely chemical means. Fuller particulars are to be given later. R. S. W.

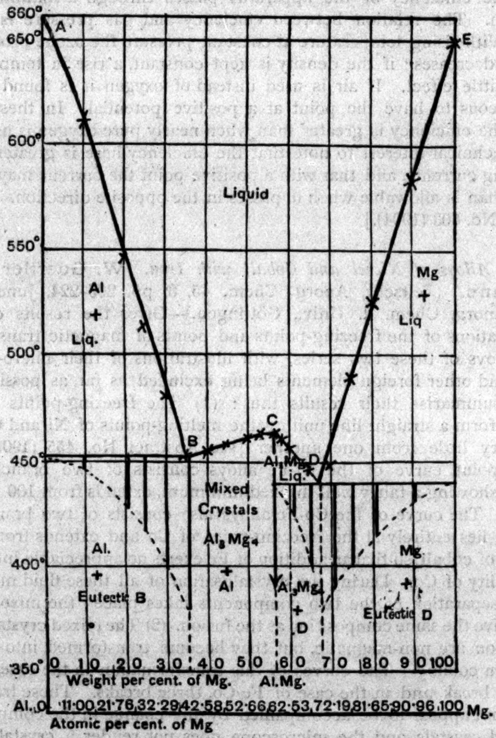
1654. *The Borchers Furnace.* **F. A. J. FitzGerald.** (Electrochem. Ind., N.Y. 3. pp. 215–218, June, 1905.) The type of Borchers furnace considered consists of a "resistor" of small diameter. This thin rod is placed between two large carbon blocks which form the electrodes. The author describes a furnace of this type used for making a quartz tube. The resistor of graphite, having a resistance of 0·00076 ohm, was completely surrounded with quartz sand. The total energy used was 5 kw.-hours, equal to an average of 1·9 kw. per sq. cm. of resistor cross-section. A quartz tube with tapering ends was produced. Owing to the low resistance of the graphite rod, heavy currents were necessary. It was sought to avoid this by changing the shape of the resistor. With the use of a hack-saw various types of resistors may be easily made from graphitised articles, such as plates with deep and narrow slots. In this way the difficulty of great length is avoided. Where it is desired to work at a lower temperature a cylinder with slots or a helical groove may be advantageously used. To prevent the furnace charge from getting into the spaces between the sections of the resistor, these spaces may be filled with agglomerated charcoal powder. Before using charcoal for this purpose it should be ignited at a very high temperature to prevent shrinkage. A satisfactory agglomerating material is a solution of sugar. Sometimes in making experiments with a Borchers furnace it may be important to avoid contact between the carbon resistor and the charge. In this case the charge may be heated by radiation from the resistor. A resistor of plate-form with V-shaped slots filled with agglomerated carbon, placed in the upper part of the furnace, is suitable for this purpose. Sketches are given of various shapes of resistors and designs of furnaces. W. W. H. G.

1655. *Production of Ozone by Point Discharge.* **E. Warburg.** (Ann. d. Physik, 17. 1. pp. 1–29, June 9, 1905.)—The discharge takes place from a point or a number of points to a plane. The voltage and current can be measured, as well as the ozone produced and the volume of air or oxygen required to produce it. The production depends very largely on the nature of the discharge. The latter in turn depends on the current; as the current is raised the efficiency of the apparatus passes through a minimum and a maximum. The relation between efficiency and gas pressure is not very clear. With rising temperature at constant pressure the ozone produced per coulomb decreases; if the density is kept constant, a rise in temperature of 80° has little effect. If air is used instead of oxygen it is found that it is advantageous to have the point at a positive potential. In these circumstances the efficiency is greater than when nearly pure oxygen is used. It is also of technical interest to note that the efficiency here is greater than for alternating currents, and that with a positive point the current may be much greater than is allowable when it passes in the opposite direction. [See also Abstract No. 603 (1904).] R. S. W.

1656. *Alloys of Nickel and Cobalt with Iron.* **W. Guertler** and **G. Tammann.** (Zeitschr. Anorg. Chem. 45. 3. pp. 205–224, June 5, 1905. Inst. f. anorg. Chem. d. Univ., Göttingen.)—Gives the results of careful determinations of the freezing-points and points of magnetic transformation in the alloys of these two series, with illustrations of their micro-structure, carbon and other foreign elements being excluded as far as possible. The authors summarise their results thus: (1) The freezing-points of Ni-Co mixtures form a straight line uniting the melting-points of Ni and Co, which differ very little from one another [see Abstract No. 455 (1905)]. The freezing-point curve of the Ni-Fe alloys consists of two branches; one of these, showing a fairly well marked minimum, extends from 100 to 30 per cent. Ni. The curve of the Co-Fe alloys also consists of two branches, one of which lies entirely at the freezing-point of Co and extends from 100 to 5 per cent. of cobalt, so that an addition of Fe exerts no appreciable influence on the fusibility of Co. During the crystallisation of all these fluid mixtures no sensible separation of the two components takes place; the mixed crystals always have the same composition as the fusion. (2) The mixed crystals formed from fusion are non-magnetic, but they become transformed into magnetic crystals on cooling. The curves of this transformation in the case of Fe-Ni show one break, and in the case of Fe-Co, three breaks. These transformations do not appear to be accompanied by any change in the composition of the mixed crystals, and the microscope does not render a crystallographic distinction between them possible. W. Ros.

1657. *Gold-Nickel Alloys.* **M. Levin.** (Zeitschr. Anorg. Chem. 45. 3. pp. 238–242, June 5, 1905. Communication from the Inst. f. anorg. Chemie d. Univ., Göttingen.)—The freezing-point curves of these alloys is given, and shows a well-defined eutectic point but no maxima that would indicate the existence of a definite compound; the cooling curves and the absence of eutectic points on the curves of alloys low in either constituent point to the existence of two series of mixed crystals, separated by a considerable interval. Magnetic permeability could readily be detected in alloys containing as little as 10 per cent. Ni and the magnetic change-point of Ni could be traced in all these alloys, at temperatures practically the same as in the case of pure Ni. The author ascribes this to the presence of mixed crystals saturated with nickel, always having the same magnetic change-point. W. Ros.

1658. *Magnesium-Aluminium Alloys.* **G. Grube.** (Zeitschr. Anorg. Chem. 45. 3, pp. 225–237, June 5, 1905. From the Inst. f. anorg. Chem. d. Univ., Göttingen.)—The work of Boudouard on these alloys is criticised and doubt is thrown on the accuracy of his temperature-concentration diagram [see Abstract No. 515 (1902)], principally on the ground that the form of the diagram does not coincide accurately enough with the requirements of the chemical formulæ he advocates; the author has therefore made a fuller study of the alloys, and the temperature-concentration diagram which he has obtained is reproduced in the annexed Fig. This diagram shows only one maximum, and the conclusion is arrived at that this corresponds to the



definite compound Al_3Mg_4. The method suggested by Tammann, of plotting the length of time occupied by the solidification of the eutectic portion of an alloy has been adopted, the various observed times being entered upon the diagram as vertical lines dropped from the eutectic line of the diagram; the maximum time of solidification as indicating a eutectic point is clearly shown. The various phases are indicated on the diagram. The micro-structure of the alloys is illustrated and is regarded as confirming the shape of the diagram. The general properties are determined by the presence of the compound Al_3Mg_4; those containing from 5 to 30 per cent. Mg are used for technical purposes; their hardness increases with increased content of Mg. The alloys with from 35 to 55 per cent. Mg form homogeneous aggregates of mixed crystals, and these are capable of fine specular polish and do not tarnish readily. W. Ros.

1659. *Catalytic Acceleration by Platinum of the Chlorine Generation from Potassium Chlorate and Hydrochloric Acid; Chlorate Formation.* **H. Sirk.** (Zeitschr. Elektrochem. 11. pp. 261–263, April 28, 1905. From the Inst. f. phys. Chemie, Göttingen.)—Experimenting on Sand's lines, the author shows that the slow reaction : $ClO' + 2H^{\cdot} + 2Cl' = 2HOCl$, is accelerated by the presence of platinum, especially when applied as spongy platinum. The author does not confirm Foerster and E. Müller, therefore, who in the chlorate formations ascribe less importance to the above reaction than to the anodic discharge :

$$6ClO + 3H_2O + 6\oplus \longrightarrow 2ClO_3' + 4Cl' + 6H^{\cdot} + 3O.$$

F. Foerster and **E. Müller** (Ibid. pp. 502–503, Aug. 4.)—Foerster and Müller maintain that their view is correct. H. B.

1660. *Nickel Plating.* **M. Grésy.** (Chem. News, 91. p. 289, June 23, 1905. Moniteur Scientif., p. 428, June, 1905.)—The author compares the electrolysis of the sulphates of copper and of nickel. In acid nickel baths, less nickel is deposited as the bath becomes more acid. When a neutral or ammoniacal nickel sulphate is electrolysed, gas is given off at the nickel anode and hydrogen at the kathode, while the electrolyte turns acid. Neutralisation with nickel hydrate or carbonate is inconvenient; ammonia impoverishes the bath; but the addition of some chloride—sodium chloride or nickel chloride itself—answers for a time. In this case more nickel is dissolved at the anode than is precipitated at the kathode, and the liquid turns basic. When the bath finally becomes turbid and the deposit poor, acidulation should be applied; sulphuric acid is more suitable for this purpose than boric acid and organic acids, which have only a temporary effect. H. B.

1661. *Electrosynthesis of Cyano-derivatives.* **C. Ulpiani** and **G. A. Rodano.** (Accad. Lincei, Atti, 14. pp. 110–114, Jan. 22, 1905.)—The authors confirm Weem's result that no dicyanosuccinic ester is formed by the electrolysis of ethylsodiocyanacetate, but only cyanocetic ester. By electrolysing an aqueous solution of ethyl sodiocyanomalonate the anions unite to form a white crystalline body, having the composition $CN.C.(COOEt)_2.CN.C.(COOEt)_2 + 1\frac{1}{3}H_2O$, and melting at 56–57°. The best conditions are a current of 0·2–0·25 amp. and a concentration of 1 per cent., which give a yield of 21 per cent. The compound decomposes on distillation both at ordinary pressure and *in vacuo*. W. H. St.

1662. *Electrolytic Precipitation of Silver.* **R. C. Snowdon.** (Journ. Phys. Chem. 9. pp. 392–398, May, 1905.)—A very finely crystalline deposit of silver can be obtained from a silver nitrate solution by rotating the kathode rapidly and keeping the anode and kathode solutions separated. The size of the crystals decreases with increase in current density and increase in the rate of stirring at the kathode. The addition of small amounts of organic colloids to the solution makes the deposit very amorphous and causes the precipitated metal to assume a colloidal state. The size of the crystals is slightly diminished by the presence of free nitric acid. T. H. P.

1663. *Electrolytic Deposition of Nickel on Nickel.* **R. C. Snowdon.** (Journ. Phys. Chem. 9. pp. 399–401, May, 1905.)—Nickel cannot be successfully plated on other nickel owing to the presence of a thin film of oxide which cannot be removed except by vigorous reduction. An adherent deposit of nickel on a nickel kathode can, however, be obtained if the kathode is first rendered "active" by subjecting it to a current density of 8 amps. per sq. dm. in a 3*n*-solution of hydrochloric acid for a few minutes, afterwards washing it in water and plunging it into the regular plating solution containing ammonium and nickel sulphates. This "active" state of nickel is very unstable. T. H. P.

1664. *Electrolytic Reduction of Nitrocinnamic Acids.* **C. Marie.** (Comptes Rendus, 140. pp. 1248–1250, May 8, 1905.)—Meta- and para-nitrocinnamic acids are reduced by electrolysis in alkaline solution to the corresponding azoxy acids, which are yellow bodies insoluble in water and the usual solvents, and only slightly soluble in boiling acetic acid or pyridine. Both dissolve in hot concentrated sulphuric acid, producing an intense orange-red colouration. Besides the azoxy acids, a certain quantity of acid-amines are also produced by the electrolysis, the *m*-acid yielding chiefly *m*-aminocinnamic acid, with a trace of *m*-amino-hydrocinnamic acid, and the *p*-acid giving only *p*-amino-hydrocinnamic acid, showing that the ease with which the lateral chain attaches hydrogen is different according as it is in the *m*- or *p*- position, which is further confirmed by the production of a small quantity of what appears to be *p*-nitro-hydrocinnamic acid, when a solution of *p*-nitrocinnamic acid is electrolysed with a current too small for reduction to azoxy acid. W. H. Sr.

1665. *Relations between Electrolytic Processes and Temperatures of Electrodes.* **W. Moldenhauer.** (Zeitschr. Elektrochem. 11. pp. 307–330, May 26, 1905. Chem.-techn. and elektrochem. Inst. der techn. Hochschule, Darmstadt.)—Reference is made to the work of Bouty (1879 and 1880), John (1888), Gill (1890), and others on the temperature changes during electrolysis. The author makes use of electrodes consisting of platinum tubes closed at the bottom, so that thermometers may be introduced. In the electrolysis of dilute sulphuric acid the temperature of the anode is always higher than that of the electrolyte to an extent depending on the current density; with 80 amps. per sq. cm., the difference is 4·9° for 26 per cent. acid and 11·7° for 72 per cent. acid. The curve connecting temperature difference with concentration rises regularly. Since the heat of the Joule effect may be neglected, the difference of temperature for every solution and arrangement is proportional to the heat of reaction of the electrode process. The temperature difference at the kathode is smaller. In phosphoric acid the phenomena observed are similar to those with sulphuric acid, but in hydrochloric acid a different anode action takes place. According to calculation, with platinised platinum, cooling must occur at the anode, but in reality a very slight heating takes place. In potassium hydroxide solutions the rise of temperature at the anode is especially great with smooth platinum. In potassium chloride solutions the anode temperature first rises to a maximum, then suddenly falls, rises again and so on, in a periodic manner; this is due to the alternate discharge of OH′- and Cl′-ions. In order to see whether regulation of the temperature leads to the formation of definite products at the electrodes, the author cools the electrodes by means of a stream of cold water passing through them. With dilute sulphuric acid the yield of persulphuric acid is increased by cooling, but the difference is small with more concentrated acid. The same holds for the preparation of ammonium persulphate and potassium percarbonate. When a solution containing 20 per cent. of potassium chloride and 1 per cent. of potassium hydroxide is electrolysed, cooling of the anode leads to formation of hypochlorite and warming to chlorate. T. H. P.

1666. *Dissociation of Electrolytes.* **C. Liebenow.** (Zeitschr. Elektrochem. 11. pp. 801–806, May 26, 1905.)—For strong electrolytes Ostwald's law of dilution does not hold, but Kohlrausch has given an empirical formula which may be converted into the form—

$$a^{3q} . C_i^3/C_\mu^2 = K,$$

where C_i and C_μ represent the concentrations of the ions and undissociated molecules respectively, a the degree of dissociation, and q and K constants. For infinite dilution, $a = 1$, so that $C_i^3/C_\mu^2 = K$, which was given by van't Hoff. Experimental observations obey equally well the formula—

$$\frac{C_i^{3-r}}{C_\mu} . e^{-k} . \int_{C_0}^{C_i} \frac{dC_\mu}{C_i} = K,$$

which is derived on the assumption that the equilibrium between the separate water molecules of different molecular size is displaced, on solution of the electrolyte, so as to favour strongly dielectric molecules; the change in properties of the water must also be proportional to the increase in concentration of the ions. The integral cannot be solved so as to give a comparison with experimental results, but it can be approximately calculated. This calculation is carried out for the molecular conductivities of potassium chloride solutions, the deviations between the observed and calculated values for λ being less than 0·1 per cent. for concentrations up to 0·1*n*. As Kohlrausch has stated that the deviations from the law of mass action of most other electrolytes are less than with potassium chloride, these other electrolytes will give results in still better agreement with the formula given above. T. H. P.

1667. *Electromotive Behaviour of Copper and Zinc with regard to their Cyanide Solutions.* **F. Spitzer.** (Zeitschr. Elektrochem. 11. pp. 345–368, June 9, and pp. 391–407, June 23, 1905. Communication from the Elektrochem. Laborat. der techn. Hochschule, Dresden.)—The author describes the preparation of his solutions and the potential measurements and electrolytic analyses, and discusses the previous literature on the subject. In solutions of the double cyanides, CuCN . nKCN or $Zn(CN)_2$. nKCN, the single potential of the metal, especially of Cu, rises with the concentration and the percentage of KCN; the results agree with Girsewald's views on the precipitation of copper from cyanides by sulphuretted hydrogen. The two metals precipitate one another from their cyanides under formation of alloys. Zinc inclines strongly to alloying; when the platinum kathodes were previously silvered or coppered, the zinc penetrated through the coatings. The deposition of the single metals from the cyanide baths is difficult; potentials above the single potentials are required, and the potentials rise with increasing current density when much hydrogen is evolved; in the presence of considerable percentages of KCN no metal could be deposited by currents of 0·001 to 0·02 amp./cm.^{2}. Mixtures of the two cyanides, however, deposit electrolytic brass already at potentials considerably below the zinc potential, and the brass becomes richer in zinc as the current rises; but the yield becomes poorer at the same time. The brass is a real alloy. Both Cu and Zn may be quantitatively deposited from solutions of their sulphates in the presence of potassium cyanide, although some platinum is dissolved at the anode and re-precipitated. The KCN retards the deposition of the metal, however, which proceeds as the cyanide is anodically destroyed. In the case of zinc, caustic soda is best added to the bath to render it weakly alkaline; in the case of copper, the addition of KCN is an altogether unnecessary complication, useless even in alkaline solutions. Zinc may also conveniently be precipitated from solutions of zinc sulphate under addition of some caustic soda, or of sodium acetate and acetic acid. In these cases Winkler's wire-net kathodes should be used. H. B.

REFERENCES.

1668. *The Electric Furnace.* **A. Minet.** (Faraday Soc., Trans. 1. pp. 77–81; Discussion, pp. 82–84; Part II., pp. 85–102; Discussion, p. 102, Jan., 1905.)—Part I. has already appeared in the Electro-Chemist [see Abstract No. 291 (1905)]. Part II. examines in detail the most characteristic types of electric furnaces as to their history, structure, or application. The period 1801–1886 is first dealt with, and a corresponding bibliography is appended. W. W. H. G.

1669. *Researches on Steel, to be carried out by International Committee.* (Soc. d'Encouragement, 107. Rev. de Métallurgie, pp. 329–334, May, 1905.)—An International Committee has been formed. The proposals outlined consist of a preliminary investigation to determine the most favourable conditions for producing, first, austenite and, second, the other constituents of steel. F. R.

1670. *Classification of Steel Alloys.* **L. Guillet.** (Soc. d'Encouragement, 107. Rev. de Métallurgie, pp. 350–367, May, 1905. Comptes Rendus, 141. pp. 107–108, July 10, 1905.)—The properties of Ni, Mn, Cr, W, Mo, Va, Si, Al, Co, and Ti steels are conveniently recapitulated, and are then classified. [See also Abstract No. 2533B (1904).] The martensitic steels have all high tensile strength and hardness, and are often brittle; the troostitic alloys are very similar, but have slightly less breaking strength and are but little changed by quenching. The troostitic steels are hardened, the troostite becoming martensite. The double-carbide steels are divided into two classes according as the carbides dissociate or dissolve (Cr, W, Mo) or do not (Va). F. R.